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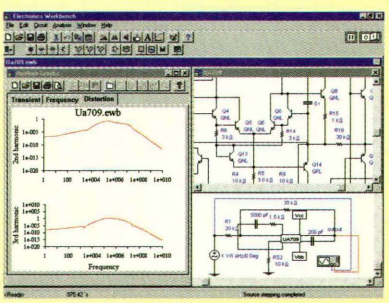

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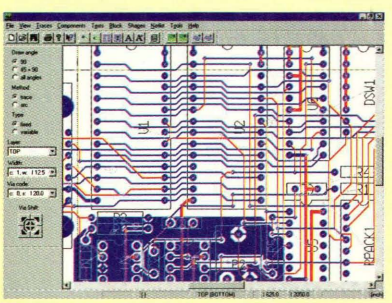

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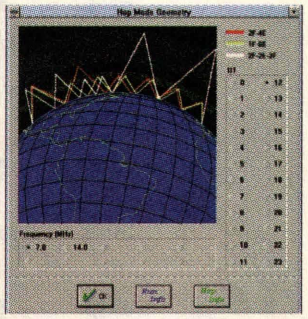

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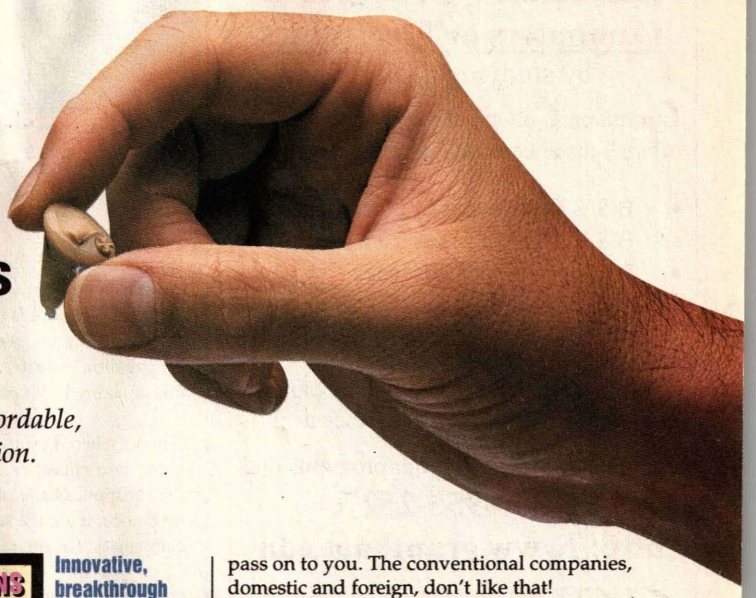
One scientist's vision revolutionizes the hearing industry, benefiting millions of people...



Crystal Ear® uses sophisticated electronics to provide affordable, cosmetically-pleasing and easy-to-use hearing amplification.

by Harold Sturman

One day a friend asked my wife Jill if I had a hearing aid. "He certainly does," replied Jill, "Me!" After hearing about a remarkable new product, Jill finally got up the nerve to ask me if I'd ever thought about getting a hearing aid. "No way," I said. "It would make me look 20 years older and cost a fortune." "No, no," she replied. "This is entirely different. It's not a hearing aid...it's Crystal Ear!"

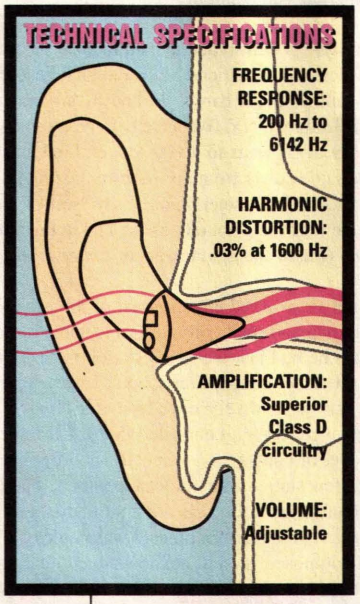
No one will know. Jill was right. Crystal Ear *is* different—not the bulky, old-styled body-worn or over-the-ear aid, but an advanced personal sound system so small it's like contacts for your ears. And Crystal Ear is super-sensitive and powerful, too. You will hear sounds your ears have been missing for years. Crystal Ear will make speech louder, and the sound is pure and natural.

I couldn't believe how tiny it is. It is smaller than the tip of my little finger and it's almost invisible when worn. There are no wires, no behind-the-ear devices. Put it in your ear and its ready-to-wear mold fits comfortably. Since it's not too loud or too tight, you may even forget that you're wearing it! Use it at work or at play. And if your hearing problem is worse in certain situations, use Crystal Ear only when you need it.

A fraction of the price. Hearing loss is the world's number-one health problem, but in most cases it goes completely untreated. For many millions of people, hearing devices are way too expensive, and the retail middlemen want to keep it that way. What's more, treating hearing loss the old retail way can involve numerous office visits, expensive testing and adjustments to fit your ear. Thanks to Crystal Ear, the "sound solution" is now affordable and convenient. Almost 90% of people with mild hearing loss, and millions more with just a little hearing dropoff, can be dramatically helped with Crystal Ear. Plus, its superior design is energy-efficient, so batteries can last months, not just weeks.

You'll feel years younger! Wear Crystal Ear indoors, outdoors, at home and at work. Crystal Ear arrives ready to use, complete with batteries, two different fitting sleeves, a cleaning brush and even a carrying case. Crystal Ear is a breakthrough advance in the hearing device field. It is made in the USA, using state-of-the-art micro-manufacturing techniques that cut costs dramatically—savings that we can pass on to you. The conventional companies, domestic and foreign, don't like that!

Don't be fooled by high prices. No hearing device, no matter how expensive, can eliminate background noise, despite claims by the manufacturers. Crystal Ear does not promise miracles—just an affordable, sound solution to many common hearing problems.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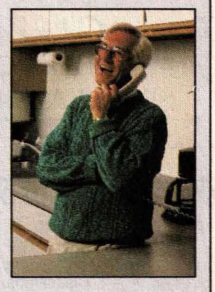

"My father spent over $5000 on another brand. I showed him my Crystal Ear, he tried it, and he decided it worked better than his brand, even though it was a small fraction of the cost!"

—A satisfied Crystal Ear user

"Over 32 million Americans experience some loss of hearing. Though most cases go untreated, over 90 percent of these people would be disappointed to learn from their doctor that there is no medical or surgical cure. There is, however, an effective treatment: electronic amplification."

—Dr. Dale Massad, MD

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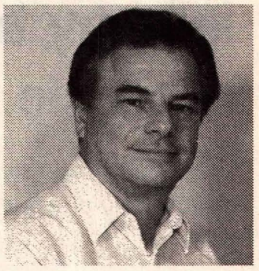
Editorial

They're Baaaack!



What's back? *Terminator II*, the ghosts from *Poltergeist*? No...it's the sunspots! That's right, after being relatively dormant for about five years, old Sol is finally starting to come back to life. Our cover story, opening on page 21, features "A Beginner's Guide to Radio Propagation"—just to whet your appetite to discover more about this amazing Earth phenomenon.

Funny, when DXers get together amongst themselves they talk about rare countries, DXpeditions, band openings, and of course, the sunspots. Some old-timers recall past sunspot cycles with such reverence, it almost sounds like war veterans recalling their fiercest campaigns. Let me tell you about my "campaign."

I was fortunate to have gotten started in ham radio at the onset of one of the highest sunspot cycles in recent times (Cycle 19). My friend Mike and I had just got our Novice licenses, and we hung out mainly on the 80- and 40-meter bands. We had an on-going competition on who could work the furthest "DX " from Brooklyn, NY. We were both on a somewhat even playing field. He was running a *Heathkit* AT1, about 40 watts to a 100-foot end-fed antenna on top of a two-story home. I was pushing about the same power from my *Johnson Viking Adventurer* on the roof of a six-story apartment house, to a "sort of" 80-meter dipole. I say "sort-of" because the wire ran zig-zag through the TV antennas on the roof (let's not talk about TVI at this time!). I believed the antenna favored the east-west direction (I used the light towers of *Ebbets Field* as my reference).

Mike and I had not yet worked anyone west of the Mississippi at that time. We would track our "DX" on his wall map and stick colored pins in some of our further contacts. Then one day Mike called me and said he had just worked a station in St. Louis, MO. I was devastated—I couldn't get past Chicago. One afternoon after school, I was experimenting with my rig and noticed that I could load up on the relatively new 15-meter Novice band (my frequency was 21,150 kHz exactly—Novices were crystal-controlled then). I listened around this frequency, called a slow CQ (in Morse code, of course) and listened—nothing but noise. Over the next few afternoons I actually worked a few stations, but all local contacts. The following weekend I called CQ and listened patiently. Out of the noise, I heard a slow methodical (– – – • • – – – – •• – • –). He repeated his callsign about a dozen times. I was panicky, I never copied a station that did not start with a K or W. I composed myself, acknowledged his call, exchanged some information, and he faded away. I looked at my station notebook and saw I copied the call OE1FT, name Franz, and QTH (location) Vienna—in AUSTRIA!

I ran over to Mike's house, and when I told him I just worked Vienna, he replied, "Sure Vienna, Virginia!" He disbelieved me and said, "Where's his QSL card?" I ran to the library, looked up OE1FT's address in the callbook and sent him my QSL card...and waited. Over the next few weeks I worked stations in FA8 (Algeria), ON4 (Belgium), PAØ (Netherlands), G3 (England) and EA1 (Spain). Mike's walls of disbelief were gradually eroding. Then the *coup d'état*—OE1FT's QSL card arrived. My pin was off the map! As the other QSLs arrived, our DX competition was over—I had won. I never realized until later how important sunspots are to amateur radio, and how lucky I was to get on a great DX band just as the solar flux was on a major upswing. By the way, Mike (who now lives in California) and I still keep in contact on the air. He never got into DX, but works 2 meters.

For those hams out there, tune your rigs to the 15– and 10–meter bands and work the world. And for SWLs—for the thrill of a lifetime, get your ham license and participate in the last sunspot roller coaster ride of this millennium—Cycle 23.

Ed Whitman

Ed Whitman
Managing Editor

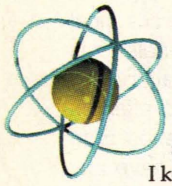
The U.S. Government always knows exactly what time it is...do you?

New clock from Arcron uses radio signals from the U.S. Atomic Clock in Colorado to display the precise time, within a billionth of a second.

Wall Clock

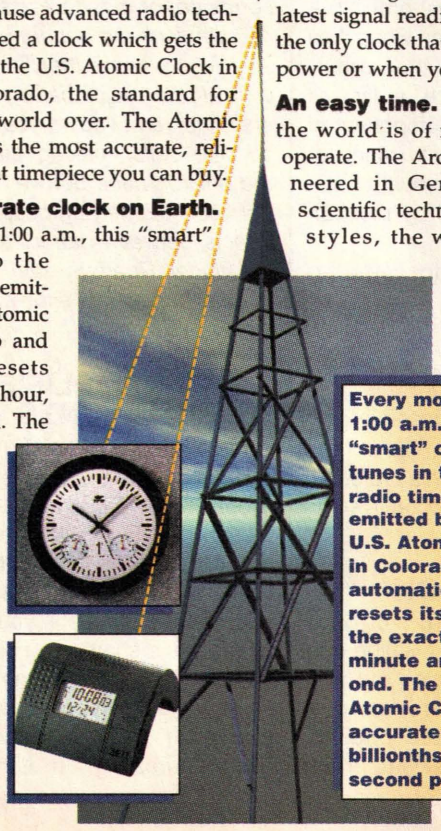
Desktop Alarm Clock

by Jake Prine



These days, timing is everything. Between meetings and appointments, deadlines and conference calls, my schedule requires that I know the time down to the minute. Even on weekends, I've got Little League games to coach, shows to tape and planes to catch. If I'm late, I'm sunk. The problem is that it's hard if my clocks aren't correct. Even the digital clocks can display time inaccurately. Power outages, dead batteries, time changes...any of these can cause a clock to be inaccurate. The next thing you know, you're strolling into that important conference...an hour late. Now there's no need to worry, because advanced radio technology has produced a clock which gets the time directly from the U.S. Atomic Clock in Fort Collins, Colorado, the standard for time-keeping the world over. The Atomic Clock by Arcron is the most accurate, reliable and convenient timepiece you can buy.

The most accurate clock on Earth. Every morning at 1:00 a.m., this "smart" clock tunes in to the radio time signal emitted by the U.S. Atomic Clock in Colorado and automatically resets itself to the exact hour, minute and second. The U.S. Atomic Clock is accurate to ten billionths of a second per day. Using molecular technology, it measures the vibration rate of atoms—a constant—to calibrate time. This means that the clock deviates less than one second over a one million year period! The Atomic Clock even adjusts automatically for daylight savings time, so you don't have to remember to "spring forward" or "fall back". This clock is the only atomic clock with an internal calibrator that creates "intelligent" adjustments based on the latest signal readings. The desktop model is the only clock that will not lose time with low power or when you change its batteries.



Every morning at 1:00 a.m., this "smart" clock tunes in to the radio time signal emitted by the U.S. Atomic Clock in Colorado and automatically resets itself to the exact hour, minute and second. The U.S. Atomic Clock is accurate to ten billionths of a second per day.

An easy time. The most accurate clock in the world is of no use if it is difficult to operate. The Arcron Atomic Clock is engineered in Germany using the latest scientific technology. It comes in two styles, the wall clock and the executive desktop model. Both are designed to be functional *and* easy to use.

The desk clock's display features the exact time (in hours, minutes and seconds), month and date, or you can choose to display any two U.S. or world time zones. It features a sleek, European design, and, at only eight ounces, is the perfect travel clock. It also has dual alarms, perfect for couples, and one-touch illumination for nighttime viewing.

The handsome wall clock comes with temperature and humidity gauges. After you install the batteries, watch the hands spin at 20 times their normal rate, until the clock has adjusted to the precise time. Both the executive desktop and the wall model have an internal antenna for superior reception sensitivity, without unattractive wires.

Imagine having the ability to know the exact time, all the time. The Atomic Clock probably costs less than most of the clocks and watches you own, but you'll be able to use it to set them all correctly. Isn't it about time you had a clock you can trust?

The time to buy is now! Act now and you can own the world's most precise timepiece. Both the executive desktop and the wall model come with a one-year manufacturer's limited warranty and Comtrad's risk-free home trial. If you are not completely satisfied, return your purchase within 90 days for a full "No Questions Asked" refund.

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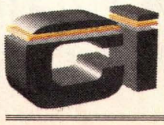

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LETTERS

THE ANSWER IS SAFETY

In the *Letters* column (**Popular Electronics**, March 1998), Joseph Carr, author of the article "Safety for Electronic Hobbyists" (**Popular Electronics**, October 1997), answered a reader's question on grounding. I have a different answer.

"Why is the center tap on the power service grounded?" **SAFETY!!** My teacher in school (a long time back) explained it this way.

Let's look at what could happen if this 110/120-volt system is ungrounded. The power line feeds several homes. In your home, the power system is now floating—there should be no shock hazard touching any line to ground. Let's say now, that your neighbor has a defective appliance. The appliance shorts one end of the service to ground; no fuses blow or circuit breakers trip. Back at your home, everything looks normal, but, unknown to you, you now have a lethal situation at some outlets in your home. Instead of having a maximum of 110V to ground (hazardous—yes, lethal—occasionally), you now have 220 volts to ground (hazardous—yes, lethal—yes). That was how he explained it.

E.M.
via e-mail

UNSUNG INVENTOR

I've just read Larry Lisle's article "Before Their Time" (**Popular Electronics**, March 1998). One other inventor whose idea fell by the wayside was Professor Woodyard of University of California-Berkeley (UCB).

In 1942, he put two points onto a piece of germanium and found he was getting a larger signal out of it than he was putting in. In other words, he had made a solid-state amplifier. He submitted a patent application through UCB's legal department. Since UCB was only interested at that time in cyclotrons, the reaction was what does a germanium amplifier have to do with cyclotrons? And no revelation of his solid-state amplifier (later called a solid-state transistor) was announced.

I came to learn about this at an IEEE meeting in 1967 in Palo Alto, CA on the 20th anniversary of the invention of the silicon transistor. On the panel were William Shockley *et. al.*, plus Dr. Woodyard, who told this story of how the transistor was really invented about five years earlier than its official date.

R.G.R.
Phoenix, AZ

A FLYBACK TESTER, ANYONE?

Every month I look forward to receiving my copy of **Popular Electronics** because it presents such an interesting overview of developments in the electronics field. As I am an electronics technician with my own repair shop, I especially appreciate the unique projects offered in each issue. I would like to suggest a project for future publication.

I repair audio/video equipment with television comprising a large portion of my business. In talking with fellow repairmen, I can attest that there is a definite need for a reliable flyback tester. While there are such testers currently available, they are either cost-prohibitive for the small businessman or, when they are economical to obtain, they simply don't work properly. Since a flyback tester is also an integral component of computer monitor repair, instructions for building one's own tester would probably be greatly appreciated by those in the computer industry.

Thank you in advance for considering this idea.

D.B.
Kenmore, NY

Well, here is another possible construction idea for those "would-be" designers out there. Add this project to the list started in the March Letters *column.—Editor*

BATTERY QUESTION

I found January's issue of your product test review on AA alkaline batteries to be very informative. You provided a concise, unbiased review on a number of the leading battery suppliers. The data presented was more than superficial, but not detailed to the depth which required an engineering degree. I look forward to similar reviews on other battery cells/types in the future.

I do have one question, however, which I have never seen addressed. I usually use the *Duracell*-brand of alkaline cell (which came out the best in your tests) in a number of toys and electrical gadgets in my house. It seems that after a few weeks of use, the metal contacts on the battery holder in the toys start building up some corrosion, or chemical reaction, with the battery terminals. This requires me to remove the battery and clean off these contacts. This effect is not noticed with similar batteries from other manufacturers. Do you have any suggestions?

J.S.
Lauderdale Lakes, FL

We are not sure what this chemical reaction could be caused by with the Duracell *brand of alkaline cells. Perhaps the humid conditions of Florida might have an effect on this corrosion, or maybe it is some strange reaction with the battery-holder material. We do know that* Duracell, *along with all the major battery manufacturers, has removed mercury from their alkaline cells, making them safer for the environment, but we are not experienced in identifying possible chemical effects between battery terminals and the holder. Readers—any similar experiences or possible explanations on this effect?—Editor*

GUITAR AMPLIFIER IMPROVEMENTS

I really enjoyed the "Guitar Amplifier" article by Rodrick Seely (**Popular Electronics**, December 1997). I remember the first guitar amplifier project you did: the "M/M/M Instrument Amplifier" in the April and May 1968 issues—and each one you publish gets better. It is a shame you did not provide a circuit description for the complementary-symmetrical power amplifier section of Mr. Seely's design, since it is quite interesting. In addition to the

short-circuit protection provided by Q5 and Q6, he uses a differential input stage consisting of Q2 and Q3, with Q2 cascoded by transistor Q1. Instead of just using diodes to bias the output stage transistors, he incorporates Q4 as a V_{BE} multiplier, which allows precise adjustment of the output stage bias current. These features are not always incorporated even in professional units, and they can greatly improve the performance of an audio amplifier.

One standard circuit which I noticed was not included is a Zobel network across the speaker. A loudspeaker is a series R-L circuit whose impedance increases with frequency. While the amplifier can drive a resistive load without any problems, inductive loads can cause an amplifier to oscillate at high frequencies because the inductance appears as an open circuit. This is aggravated because there is no capacitor across R21 to roll-off the high frequency response. A Zobel network is a series RC compensation circuit which is connected across the speaker. With properly selected resistor and capacitor values (a stable film capacitor should be used), the impedance seen by the amplifier output stage can be made to appear constant. This can be shown specifically in the formula, $C_ZR_Z = L_S/R_S$—where the subscript "z" represents the Zobel values and the subscript "s" refers to the speaker values.

As an example, let's assume the speaker has a DC resistance of 8 ohms and an inductance of 10 μH (the actual values should be available from the speaker supplier). In order to have the amplifier load appear as a constant 8 ohms, you select:

$$C_Z = L_S/(R_ZR_S) = 10\ \mu H / (8 \times 8) = 0.156\ \mu F$$

Thus, by connecting a series combination of an 8-ohms resistor and 0.15-μF capacitor across the speaker, the amplifier will be unconditionally stable at all frequencies.

C.H.
Tinton Falls, NJ

HAVES & NEEDS

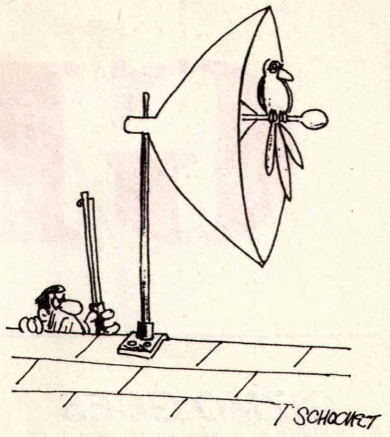
I would like to ask my fellow **Popular Electronics** readers for some help. I am looking for a circuit diagram for a device that indicates when the telephone line is busy.

Any response will be greatly appreciated. Thank you for any help you can give me.

Brenden McNeil
203 S. Cleveland Ave.
Elsmere, DE 19805
e-mail: brenden_mcneil@hotmail.com

I am looking for a circuit which shows you how to interconnect two telephones to make an intercom. I think I saw something in **Popular Electronics** about ten years ago. Any references provided will be appreciated.

Al Conforti
via e-mail: xalbex@aol.com ■



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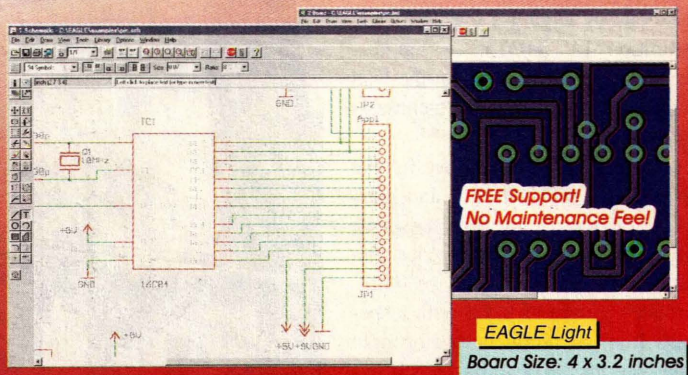

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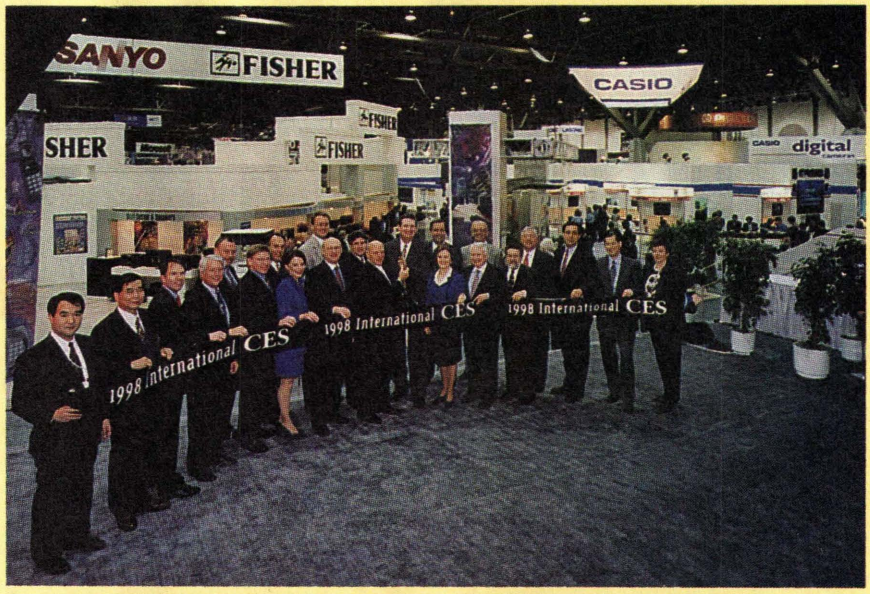
GIZMO GOES TO VEGAS!

A look at the hot new products and technologies shown at the 1998 International Consumer Electronics Show

Amidst the hustle and bustle, hype and hoopla of the 1998 International Consumer Electronics Show (ICES) this January in Las Vegas, video technologies took center stage. Don't get us wrong; there was plenty happening in the worlds of audio, computers, telecommunications, and personal electronics. Throughout the Las Vegas Convention Center, the Sands Convention Center, and several surrounding hotels, manufacturers displayed a huge variety of consumer-electronics gear, ranging from such mundane items as carrying cases and home-theater furniture to high-end audio and video products. But you couldn't turn around without coming face to face with demonstrations of Digital TV (DTV) and High-Definition TV (HDTV)—often displayed on large-screen, hung-on-the-wall plasma-display monitors that are as little as 4-inches thick.

In our ICES 98 roundup, we'll take close-up looks at DTV, HDTV, and plasma-display devices, and then describe some of the other neat technologies displayed at the show. Next month, we'll present a broader picture of ICES with a special "Wish List" of products that brought home Innovations 98 awards in various product categories.



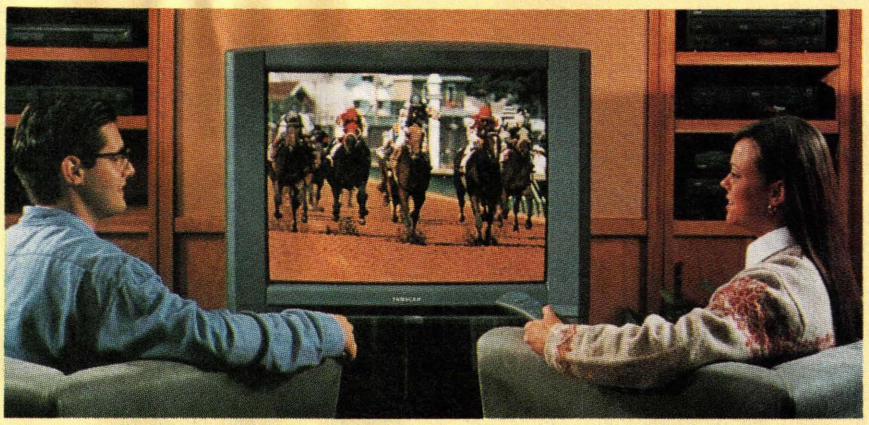
Displays of HDTV sets drew crowds at a dozen booths in the Las Vegas Convention Center, including Pioneer's, shown here.

HDTV VS. DTV

Drawing crowds to more than a dozen booths at ICES 1998 were high-definition televisions that were showing actual, real-time, real-life HDTV broadcasts, provided by two local stations: KLAS-TV (CBS) and KLVX (PBS). At previous shows, HDTV sets displayed prerecorded Japanese programming. The 1998 ICES marked the debut of the first live U.S. HDTV broadcasts, generating plenty of excitement and more than a little confusion.

The experimental HDTV feeds are forerunners of the HDTV rollout that's scheduled to begin this fall, which is also when the first HDTV sets are expected to

The Consumer Electronics Manufacturers Association hopes the new DTV certification logo, which signifies that a product is capable of receiving and displaying all ATSC video formats, will help reduce consumer confusion. A CEMA/ATSC certification program will allow manufacturers to assess their products for conformance to the ATSC standard.



Thomson's ProScan PS3800 multimedia monitor is an interim product, providing peak video performance from today's DVD players and Internet access devices, and tomorrow's digital set-top converters.

become available. That doesn't necessarily mean that you'll be able to see any HD broadcasts, however, even if you do have the big bucks needed to buy one of the first-generation HDTVs. First, initial broadcasts will reach only the top ten U.S. markets (Atlanta, Boston, Chicago, Dallas, Detroit, New York, Philadelphia, Los Angeles, San Francisco, and Washington, D.C.). Second, no one has quite reached a consensus on HDTV standards (although the finalized HDTV standards might be released by the time you read this). Third, broadcasters must decide how much bandwidth they're willing to allocate to HDTV and how much to digital standard-definition TV (SDTV).

As we go to press, this much is known: HDTV will deliver about twice the resolution of National Television Systems Committee (NTSC) TVs. At the minimum, HDTV will offer a vertical display resolution of 720 progressive/1080 interlace (or higher): the ability to display a 16:9 image at that resolution; the ability to receive all Advanced Systems Television Committee (ATSC) table formats; and the ability to receive, reproduce, and/or output Dolby Digital (AC-3) audio. The Federal Communications Commission has mandated that broadcasters must begin the transition to digital in the top ten markets by May 1999 and in the top 30 markets by November 1999. Analog signals will continue to be sent at least through 2006. Some cable operators, such as HBO, and satellite providers, such as DirecTV, have announced that they will broadcast HDTV programming later this year.

But the "transition to digital" doesn't necessarily mean the broadcasting of HDTV. Digital TV is a broad umbrella term that encompasses not only HDTV, but also digital standard definition TV and several other potential systems. The SDTV format, as you'd expect, delivers lower resolution than HDTV and doesn't have a specified aspect ratio. An SDTV product or system must have the ability to receive all ATSC Table III formats and to produce "usable audio" and "a usable picture." There is no specified aspect ratio for SDTV.

Under the FCC ruling, broadcasters must switch to digital. However, they still have a lot of options. For example, given its new channel assignments, a TV station could choose to broadcast one or two high-definition signals, or multiple SDTV signals. It boils down to quality vs. quantity, because several SDTV broadcasts take up the same bandwidth as one HDTV signal. Will HDTV stations demand (and get) higher advertising revenues? Or will broadcasters fare better economically with more stations and less resolution? Those questions are yet to be answered.

What does all this mean to you as a consumer? First, if your old TV is on the fritz, or you've been considering making the move to a big-screen set, don't put off the purchase while awaiting a digital set. Television sets have an average life-span of 8 years. So if you buy one now, by the time it needs replacing, DTV sets will be a well-established, and perhaps even reasonably priced, commodity. (Right now, they're running from $2000 to $5000 more than comparable analog models. Current estimated prices for first-generation HDTVs are even more prohibitive, with starting prices between $8000 and $10,000! Consumer-electronics products generally cost half their "introductory" price—in some recent instances, much less—by their tenth anniversary.) If digital TV really takes off in the meantime, you'll be able to buy a less expensive set-top converter box that will allow your 1998 or older set to receive digital broadcasts as well as analog ones.

Keep in mind that it was a full decade after color TV's introduction that the one-millionth color set was sold. HDTV is expected, by some, to have a much slower acceptance rate due to initially prohibitive retail costs, limited programming options, and the fact that today's viewers, who already enjoy better pictures and sound than ever before from a range of digital sources, don't perceive the same urgent need that spurred color-TV sales.

According to the Consumer Electronics Manufacturers Association (CEMA), conservative estimates predict that 30% of U.S. households will have digital sets by 2006. On the other hand, consumer acceptance of such formats as digital satellite transmissions, DVD, and Dolby Digital might indicate that we are getting primed for HDTV.

The consumer-electronics and broadcasting industries face a number of hurdles in the race to deliver HDTV to the American viewing public. First and foremost, perhaps, is convincing less technologically aware viewers that they might want and need digital TV—a challenge in light of the fact that, according to a study on DTV conducted by the Verity Group, most Americans have little or no idea what DTV is and what HDTV can mean to them, and that some confuse DTV with other technologies, such as DVD and Digital Satellite System (DSS). Clearly, an all-out public-education campaign is needed. The Verity study also found that if peo-

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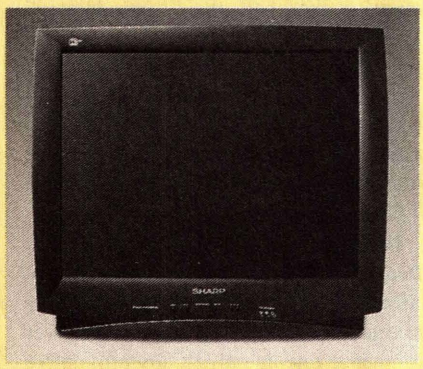
ple are going to spend the money on a DTV set, enhanced picture quality is not enough. The set had better offer increased functionality—for instance, computer capabilities and interactivity—and improved sound quality, as well as excellent programming choices, or the buying public won't buy.

Broadcasters, on the other hand, face huge initial expenses in building large HDTV transmission towers and purchasing the necessary equipment, and have worries about new interference sources. Perhaps that's why, out of all the stations in the top ten markets, only 26 have adopted the accelerated production schedule needed to begin digital broadcasting by year's end.



Sharp's 36-inch DTV-ready analog set has 800 lines of resolution, and component video inputs for use with DVD players and DTV converters.

What if you just *have* to be the first one on your block to have a digital TV or HDTV set—and you have deep pockets or a terrific credit line? If you can wait until the fall, you're in luck. More than a dozen manufacturers showed prototypes or actual products or announced marketing plans for such. To resolve the current standards confusion, virtually all of the DTVs shown have the ability to receive 1080i HDTV signals as well as the 17 other formats that fall under the DTV heading. (No, 1080i is not another form you have to complete and mail to the IRS by April 15. It refers to 1080 interlaced lines of resolution—as compared to today's 525 interlaced lines—and if it's not found in a DTV's specifications, that set is not HDTV compatible.)

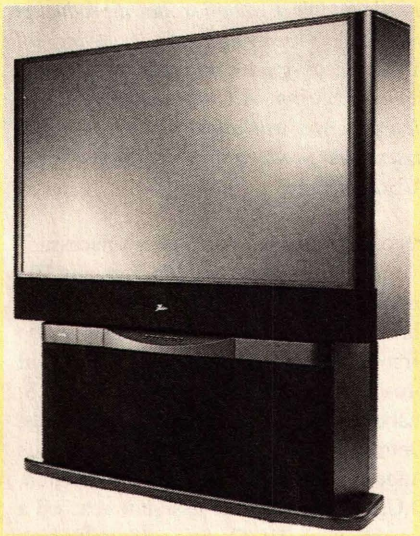
Thomson Consumer Electronics not only showed HDTV hardware but, along with DirecTV, hosted a demonstration of the first-ever HDTV direct-to-home satellite feed. DirecTV announced that it would begin transmitting two HDTV channels nationwide over the DSS satellite system sometime this year. At the joint press conference, the companies pointed out that if just one percent of the current 4 million DSS subscribers decided to purchase a high-definition television, that would translate to 40,000 sets. Thomson hopes some of those bought will be its ProScan 61000 61-inch, 2,073,600-pixel (1920 × 1080 interlaced) HDTV set. The 61000 HD set has a suggested retail price of $8000. Thomson also displayed two ProScan multimedia TVs that are converter-box-ready and offer data-grade picture tubes. They will be available later this year at prices yet to be announced.

Mitsubishi hopes to introduce three or four models in its HD-1080 series before the end of this year. The mid- to large-screen sets will have suggested retail prices ranging from $8000 to $11,000. In addition to 1080i HDTV signals, the sets will provide full Dolby Digital 5.1 channel output, and enhanced NTSC processing to dramatically improve analog images.

Sharp was displaying a variety of DTV prototypes on the show floor. Said Robert Scaglione, director of product planning, "We are taking a broad approach that will provide consumers with a variety of options, from set-top boxes that will let consumers receive DTV signals on their existing sets to widescreen HDTV projection sets capable of tapping DTV's full potential. Prototypes displayed at the show included a 1080i front projector with a 100-inch screen, digital set-top boxes, and direct-view and rear-projection DTVs." In terms of real products, Sharp plans to make available early this year DTV-ready component-input analog televisions, in 27- to 36-inch sizes, as well as several DTV-ready SharpVision LCD projectors.

Zenith's digital HDTV receiver/decoder (top), combined with the company's Pro900 high-definition front-projection monitor (bottom), provides a full HDTV home-theater or commercial package, delivering high-definition images up to 200 inches diagonal.

Zenith is also taking several different approaches to HDTV. The company plans to begin marketing its Digital HDTV Receiver/Decoder this spring. The Zenith-Inteq model IQADTV1W is a stand-alone unit that includes the Zenith-developed vestigial sideband (VSB) demodulation system, MPEG-2 video decoding, and



The Zenith-Inteq 64-inch widescreen HDTV set will be available this fall.

Dolby Digital audio decoding. Combine it with Zenith's PRO900 high-definition front-projection monitor for a complete HDTV package, with images up to 200 inches diagonal. The company's first integrated HDTV set is a 64-inch diagonal widescreen rear projector, Zenith-Inteq model IQA64W10W, which will be available this fall for "more than $10,000." It will provide 1920 × 1080 HDTV resolution, Dolby Digital audio processing, and a 15-pin VGA computer input (along with three S-Video jacks, 15 composite video jacks, and four RF inputs).

John Briesch, president of Sony's Consumer Audio/Video Products Group, speaking from Sony's "unique vantage point as the only company involved in virtually every aspect of the digital television chain—from broadcasting and content creation to TV set manufacturing" noted, "We believe the transition to digital TV ... will not take place overnight. It will certainly be more complex than when consumers switched from black-and-white TVs to color sets." During the transition period, Sony plans to introduce a "total range of home entertainment solutions" including HDTV products this fall in the ten markets scheduled to receive HDTV broadcasts, converter boxes, and a flat-display

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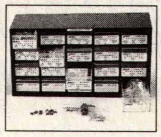

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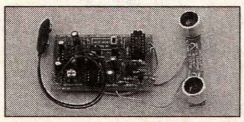

- Detects motion from 4-7m away
- Switchable latch, red LED indicator
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- Requires 9V battery (not included)

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DC to Pulse Width Modulator

The circuit converts a DC voltage into a series of pulses, such that the pulse duration is directly proportional to the value of the DC voltage.

- Operating voltage: 8 to 35VDC • PWM range: 0 to 100%

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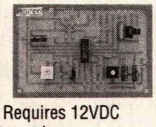
JE 2206 Function Generator Kit



Produces sinusoidal, triangular (saw-tooth), and square wave-forms at frequencies continuously variable from 1Hz to 100kHz. Requires 12VDC supply or ±6VDC split supply.

- 21 piece kit (chip, components, PC board, hardware)

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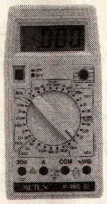

- 3½-digit LCD (.5" high digits)
- AC voltage: 200mV, 2V, 20V, 200V, 700V
- DC voltage: 200mV, 2V, 20V, 200V,1000V
- AC & DC current: 20µA, 200µA, 2mA, 20mA, 200mA, 2A, 20A
- Resistance: 200Ω, 2KΩ, 20KΩ, 200KΩ, 2MΩ, 20MΩ • Input impedance: 10MΩ
- Auto zeroing • One-year warranty

Part No.	Product No.	1-4	5-9
27115	M3800	$39.95	$35.95

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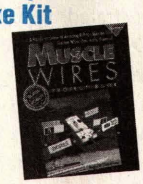

Get the facts behind the unusual properties of Muscle Wires. Study their uses in heat engines, industrial, medical and aerospace applications, electronic and mechanical devices, prosthetic limbs, robotics, virtual reality systems, and more!

- Includes Flexinol, crimps and instructions

Part No.	Description	1-4	5-9
141348	Muscle Wires kit	$59.95	$53.95

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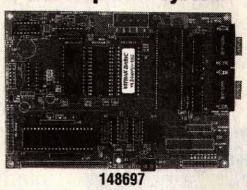
Control, Measurement, Data Collection Self-Contained Development System



148697

Kit or Fully Assembled

- 24 digital I/O lines
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- 16KB EPROM space for application code
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  - sup. float point, strings, integers, arrays
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Part No.	Description	Price
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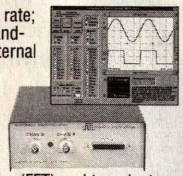
148697	ViTRAX – assembled	159.95
148734	A/D converter module, 10-bit, 8-ch	39.95
148726	RealTime calendar clock module	39.95
148718	LCD interface port: 2 x 7 pin mod.	19.95
134658	Novation power supply	6.95

mission technology PC-Multiscope 2



- 20MHz sampling rate; 10Mhz analog band-width; built in external trigger
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Part No.	Description	Price
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- Supports EPROMs, EEPROMs and Flash memories up to 8Mbits
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- 48 TTL/DTL compatible digital I/O lines arranged into 8-bit ports
- Software programmable for inputs/outputs
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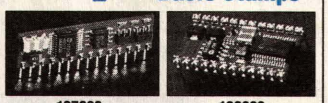
Part No.	Description	Price
136784	48-bit digital I/O card	$99.95

PARALLAX Basic Stamps



127693 130892

Basic Stamps are small computers using a variation of Basic, called PBASIC to control execution of many applications. The BS1-IC has 8 I/O lines, while the BS2-IC has 16 I/O lines which can be connected directly to buttons, LEDs, registers, and many other TTL level devices. • One-year warranty

Part No.	Description	Price
127693	Basic stamp BS1-IC	$34.95
130892	Basic stamp BS2-IC	49.95

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- Easily plugs into a parallel port

Part No.	Description	Price
147264	Photo scanner ... Special	$69.95

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- Changes course when it comes in contact with an object or hears a loud sound

Part No.	Description	Price
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- Low static plastic body – CMOS safe
- Nickel plated clips designed to withstand up to 5,000 insertion cycles

Part Number	Contact Points	Size L x W	1-9	10-49
94457	100	6.5 x 0.4	$2.49	$2.25
20600	400	3.3 x 2.1	4.95	4.49
136901	1,600	5.5 x 2.3 ... SALE		19.95
20669	630	6.5 x 1.4	5.49	4.95
20722	830	6.5 x 2.1	7.95	6.95
20757	1,360	6.5 x 3.1	11.95	10.95
20773	1,660	6.5 x 4.3	17.95	15.95
20790	2,390	6.9 x 5.8	22.95	20.49
20811	3,220	7.3 x 7.5	30.95	27.95

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Part No.	Description	1-4	5-9
141680	EDWin NC	$149.95	$134.95

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Part No.	Description	Price
146595	40 watt soldering station	$44.95

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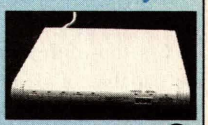

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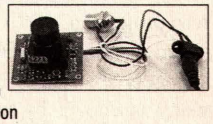
- $15,000 connected equipment manufacturer's warranty

Part No.	Description	Price
147011	Power base ... Special	$24.95

SHARP Camera Board

Black and White



- EIA system 512(H) x 492(V)
- Composite output – 380 lines resolution
- 1/50 to 1/1000 sec. shutter speed
- 2.1mm female center positive

Part No.	Description	1-4	5-9
127263	Camera board	$129.95	$116.95

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Philips' 64-inch rear-projection HDTV set features full ATSC and NTSC decoding, maximum display of 1080 × 1925 interlaced lines of resolution, and Dolby Digital surround sound.

Trinitron "Wega" TV.

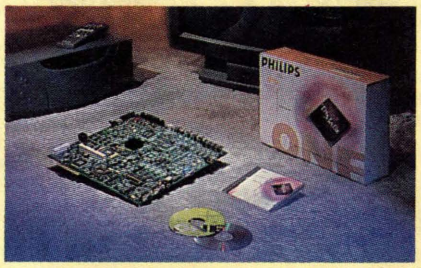
Philips Consumer Electronics Company president and CEO, Robert Minkhorst, expressed a more optimistic view: "1998 will be a historical year as the television industry enters the Digital Era, and Philips is excited to be a leader in this transition with our first HDTV offering"—a 64-inch widescreen rear projection set slated for fall availability. "The transition to digital marks a paradigm shift in how consumers will experience television in their homes—much the same way that the transition from black-and-white to color changed television in the 1950s and 60s."

Panansonic, which had already introduced a "digital-ready" SVGA TV/monitor, displayed at ICES a prototype 36-inch widescreen direct-view DTV, a 56-inch widescreen rear-projection TV, and a set-top converter box, all still under development but expected to be available this fall. JVC's top-of-the-line front-projector will be capable of delivering HDTV signals. Samsung's SVP-555JHD 1080i HDTV features an MPEG-2 video decoder, a universal format converter to translate any DTV or NTSC signal to 1080i or 720 or 480 progressive scan, and a Dolby Digital decoding system for HDTV and DVD.

Unity Motion, which bills itself as "HDTV programmers and equipment integrators," plans to provide both HDTV programming and a satellite dish capable of receiving it, along with direct-view and rear-projection HDTV sets. Initial tests are slated to begin in February, four to six channels are expected by summer, and as many as a dozen by fall. The company will market complete packages, consisting of, for instance, a 28-inch widescreen set, Ku-band dish, and integerated receiver-decoder (IRD) ($5500). Substitute the 72-inch rear-projector, and the price jumps to about $10,000. Programming will run about $50 a month.

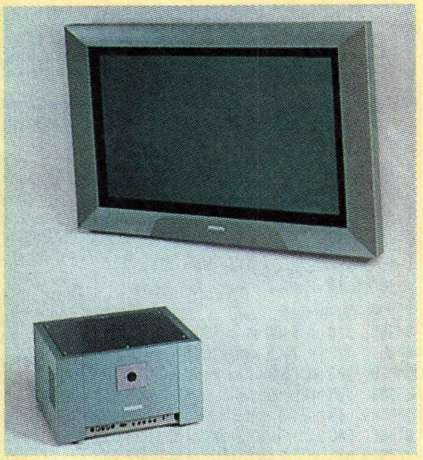
In other HDTV satellite news, EchoStar reacted to the DSS HDTV demo with an "anything you can do we can do better" attitude. EchoStar is currently the only U.S. Direct Broadcast Satellite (DBS) provider to use an MPEG2 world standard transport. It also claims "twice" the capacity of any of its competitors, even before the March 1998 launch of another satellite. EchoStar promises to begin HDTV transmissions as soon as the digital TV sets and programming are out there.

On the business end of DTV, Philips Semiconductors demonstrated the first in a series of TriMedia DTV reference platforms, a complete reference design for developing Advanced Television Systems Committee (ATSC) TVs, set-top boxes, and PCs, supporting all 18 ATSC standards from SDTV to HDTV and easily programmed to provide custom features and to support additional applications such as video e-mail, video telephony, Internet access, and communications. The platform includes both hardware and software to allow manufacturers to quickly develop ATSC products. So far, Philips Electronics Sound & Vision Group and Samsung Information Systems America have announced plans to use the TriMedia DTV reference platform.



Philips Semiconductors' TriMedia programmable DTV reference platforms allow hardware and software manufacturers to quickly develop ATSC products.

Zenith chose the ICES venue to declare its collaboration with Intel Corporation in the development of demodulator cards that will allow PCs to receive DTV broadcasts, including data services. Intel's Tom Galvin, director of market development, digital broadcast and broadband, said the joint development effort "supports Intel's vision of bringing exciting digital content and broadband services to millions of Intel Architecture-based computers around the world." Intel has integrated Zenith's VSB technology into a prototype PCI board design for cost-effective PC implementation. Zenith's VSB digital transmission system was adopted by the FCC as part of the ATSC DTV broadcast standard. Any consumer product that receives an ATSC DTV signal will use Zenith's patented technology. Now, in addition to licensing VSB to DTV manufacturers, Zenith plans to license its DTV technology to the PC industry, under terms that have yet to be disclosed.



The electronics for Philips FlatTV plasma television are housed in a separate unit, shown in front. The 4.5-inch thick set features data/video display capability, multistandard display compatibility, and a 160-degree viewing angle.

Just before the Consumer Electronics Show, Sony announced that it plans to work with NextLevel Systems Inc. to jointly develop digital TV technologies and HDTV products for cable TV users. At its ICES presentations, Sony emphasized its deep involvement in behind-the-scenes aspects of DTV, from supplying broadcasters with HD cameras, monitors, editing and special-effects equipment to transferring an archive of more than 200 films to high-definition digital video.

What does it all come down to? The technologies are there, ready for use. And the end result is terrific. (We particularly enjoyed Runco's elaborate high-definition home theater. Granted, all its varied components probably cost more than the average house, and the speaker arrays were the size of a small car. Even the non-HDTV digital source material (DVD) looked and sounded great, but the step up to HDTV was a noticeable improvement.) But it will take several more years, at best, for HDTV to hit the mainstream. Meanwhile, we'll be hearing a lot more about digital and high-definition television, as the consumer-electronics indus-

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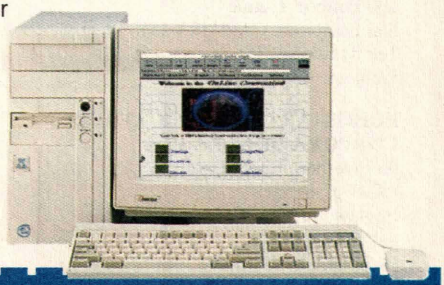

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VIDEO HANG-UPS

Another one of those technologies that the industry has been promising for decades now is a television that is flat enough to hang on the wall like a picture. Well, they're here. Flat-screen TVs were hanging from the walls at booths all around ICES 98. The good news is: They look really great—wide screen, slim profile, very high "cool" factor. The bad news is: The picture quality still ranges from so-so to very good (with high-definition feeds), and the price is still sky high.

A sampling of some of the MD products Sony is rolling out in 1998, which it has dubbed "the year of the MiniDisc."

Basically, a plasma set uses a layer of fluorescent gas sandwiched between two thin glass panels in which rows and columns of electrodes are embedded. When a relative low-voltage is applied to the electrodes, the pixels at their junctions emit light, the color of which is determined by which phosphor pigment (red, green, or blue) is being addressed. The result is a very flat array of individually addressable pixels, providing for precise image control. The depth requirements of a traditional cathode-ray tube or CRT—with its electron gun and large, heavy glass envelope required to contain a high vacuum—are eliminated. Thus, plasma sets can use much thinner, lighter, flatter screens. That, combined with the fact that light is evenly distributed all over the entire screen, allows the flat TVs to be viewed from angles of up to 180 degrees.

Various manufacturers are involved in the development of a number of different gas plasma technologies. A hybrid technology known as PALC, (for plasma-addressed liquid crystal) was developed originally by Tektronix and has been licensed by Sony, Sharp, and Philips. Those companies are now striving to create a flat-screen display that will be less expensive to produce than similar plasma or thin-film transistor (TFT) LCD monitors while offering better picture quality.

It was difficult to turn around on the show floor without encountering flat-screen TV. Mitsubishi, Fujitsu, Hitachi, JVC, Thomson, Sony, Philips, Panasonic, Sharp, Samsung, and Pioneer were all showing them, although not all of the demo models are currently available to the public or even have definite marketing plans.

Sharp's MD-X8 minisystem lets you download audio from the Internet and record it to a MiniDisc. An optional digital sound card is required for connection to a PC or laptop, which can then be used to control the music system and to edit and title discs and tracks.

Fujitsu, the first company to sell plasma displays in the U.S., unveiled its second-generation Plasmavison 42 at ICES 98. It offers a 400:1 contrast ratio (the original model was only 70:1), component video input, SVGA compatibility, 42-inch-wide screen (diagonal) and is less than 6 inches deep. Its suggested list price is $10,999.

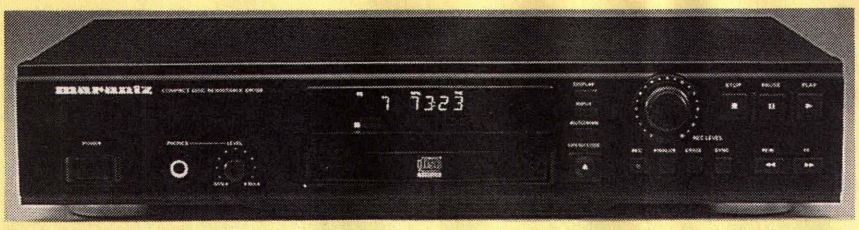
Test marketing of Mitsubishi's DiamondPanel Television began last Christmas. Two dealers in Los Angeles were offering the 40-inch-wide, 4-inch thick, flat-panel plasma-display TVs (a wall-mount and a table-mount)—the first to be marketed in the U.S.—for about $10,000 apiece. A separate control unit functions as the TV tuner, input selector, and audio amplifier. At ICES, Mitsubishi displayed a 46-inch DiamondPanel DTV-ready television, which will be ready in the second half of 1998.

Philips' 42-inch widescreen FlatTV Plasma television is 4.5-inches thick and has a 160-degree viewing angle. It offers video and data display capability and a complete Dolby Pro Logic surround-sound system with nine speakers built into a frame around the display (a stand-alone subwoofer and rear speakers are also included). Compatible with NTSC, PAL, and SECAM standards, the FlatTV is HDTV-ready with the addition of a set-top converter box. The electronics, power supply, and connectors are housed in a separate TV receiver. The complete system is slated for delivery early this year, with a suggested retail price of $14,999.

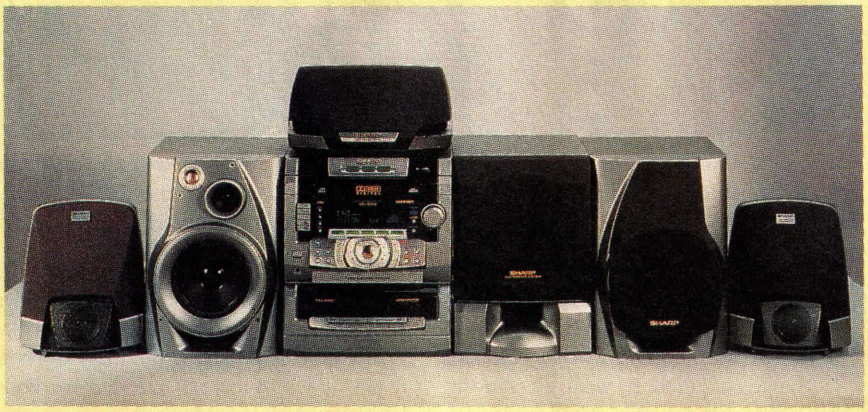
Thomson's prototype plasma TV has a depth of just 4-inches. Intended for both home-theater and conference-room use, the set is scheduled to reach dealers in time for Christmas 1998, with prices to be announced.

Sharp displayed a 42-inch PALC-based set, which the company hopes to market this fall, followed by a high-definition version by the end of 1999. Sony, which is already selling PALC-based Plasmatrons in Japan, took a different route at ICES 98, introducing the "Wega" (pronounced "Vega") Trinitron, a flat-screen tube-based set. It uses the FD Trinitron tube, which is flat both horizontally and vertically for "minimal glare and virtually no distortion." A larger deflection yoke and longer electron gun than those found in previous Trinitron sets promise precise corner-to-corner focus. Wega also uses two new Sony technologies: Direct Reality Creation, said to "effectively double a picture's horizontal and vertical resolution," and Multi Image Driver, which converts most standard video source signals to a

Philips Audio CD Recorder, which premiered in "select" audio shops last fall, will be available through mainstream retailers this year at a suggested retail price of $649.



The DR-700 CD-R/CD-RW recorder from Marantz offers direct-to-digital and analog dubbing capabilities on record-once and re-writeable CDs.



The first Dolby Digital-equipped audio minisystem is Sharp's CD-C492, with 240-watt amp, three-disc CD changer, AM/FM digital tuner, double cassette deck, and six speakers.

higher resolution level.

Cool as they might look, don't expect plasma sets to make any inroads on traditional CRT and projection sets in the next few years.

THE HEAR AND NOW

Meanwhile, back in the real world, several new and not-so-new technologies are being refined and even redefined. Hot audio technologies include recordable digital audio and a slew of home-theater audio solutions.

DIGITAL RECORDING OPTIONS

Sony has declared 1998 "the year of the MiniDisc"—which basically means it's spending big bucks to promote a format that has, so far, been less than a roaring market success in the U.S. We've always liked the format for its sound quality, portability, and, of course, recordability. So have consumers in Japan and Europe. But, other than a prototype of a computer-based CD-to-MD recording/editing system, Sony displayed revamped and expanded lines of the basic home, car, and portable models.

Sharp, on the other hand, was showing (and is currently selling) a truly innovative MD product. Its MD-X8 minisystem allows users to digitally download and store audio from the Internet to a MiniDisc. Record companies and music services offer music on their home pages, and more than 40,000 Web sites broadcast Real Audio and Webcasts. You can find simulcast concerts, college sporting events, and recording samples of signed and unsigned bands on the Internet. The MD-X8 connects to a computer through an optional PCMCIA adapter. Once connected, the PC or laptop can be used to control many of the minisystem's functions, and to edit and title tracks using the computer keyboard. The system can also record music from other digital sources, such as DSS, Digital-Audio Tape (DAT), and, of course, CDs. The MD-X8, with three-disc CD changer, AM/FM digital tuner with 40 presets, front-loading MD player/recorder, and 80 watts of total power, has a suggested retail price of $899.95. The Digital Sound Card with cable costs $299.95.

One of the reasons that consumers have been reluctant to buy MiniDisc products is their unwillingness to begin collecting another whole set of hardware and software—car, home, and portable tape decks, CD players, and MD recorder/players. Now, however, it's possible to record your own CDs and play them back, with no loss of quality, on the equipment you already own. CD-Recordable (CD-R) recorders are still scarce, but they're out there, as are CD-ReWritable (CD-RW) devices.

Although they offer CD-quality sound, in contrast with MiniDisc's "near-CD quality," CD-RWs can't match the editing or playback capabilities of MDs. For example, you can only re-write the last track on the disc—to replace an earlier track, you have to also erase all the tracks that follow it on the disc. Worse yet, because of CD-RW discs' low reflectivity, they can't be played back on most conventional CD players. (CD-Rs don't have that problem.)

Starting next year, Philips plans to redesign its whole line of CD players so that they will be MultiRead-compatible and will play CD-RWs. Pioneer's new DVD players also will play back CD-RWs (and presumably other manufacturers will follow suit). So, if you really want to buy a CD-RW recorder now, you can use it to record CD-Rs until you are ready to buy, and the manufacturers to sell, a new CD or DVD player that is compatible with CD-RW media. Finally, consumer audio CD-RW machines (but not PC CD-RW drives) require the use of special "consumer" blank discs that are more expensive because their cost includes a royalty payment. They also contain some anti-piracy features to prevent digital bootlegging.

Philips' Audio CD-Recorder, which has been available since last fall, allows you to make your own CD mixes, is compatible with both CD-R and CD-RW media, and has a suggested price of $649. Philips also exhibited its OMNIwriter/12 CD-ReWriteable storage solution at ICES 98. The PC peripheral device allows users to read, write, and rewrite their CDs, and also can be used for true backup of large-capacity media. OMNI/12 can create CD-R and CD-RW audio discs, and can read CD-ROMs. CD-RW media can be read by DVD-ROM drives and can record DVD readable discs. The OMNI/12 has a suggested list price of $499.

Pioneer, which has been selling CD-R recorders for the last four years, introduced the PD-R55RW re-writeable CD recorder at ICES. The unit features a sampling frequency converter for easy digital-to-digital recording of non-CD sources, such as MD, Digital-Compact Cassette (DCC), and DAT, and track-by-track digital synchronization. When recording from analog sources, an automatic level control system maintains a steady input level. The PD-R55RW is expected to be available this summer.

Marantz also introduced a CD-R/CD-RW deck. The DR-700 CD recorder automatically converts digital audio recorded at

different sampling rates to the 16-bit, 44.1 kHz CD standard when transferring data to disc. Optical and coaxial digital inputs and outputs are provided, as are analog connections for recording tapes or LPs. The DR-700 will ship in mid-1998; prices have yet to be announced.

HOME THEATER—SOUNDING GOOD!

Other audio news at ICES revolved around home-theater sound: Dolby Digital, THX, DTS, and Virtual Dolby.

The big news in 5.1-channel Dolby Digital is price drops. Sherwood, for instance, plans to have a $399 Dolby Digital receiver on the market in late summer. Several other companies have models with expected street prices of less than $450. Sharp displayed the first Dolby Digital mini-system. The CD-C492 features a 240-watt amplifier, a three-disc CD carousel changer, AM/FM digital tuner, double cassette deck, and six speakers. It will be available in May with a suggested retail price of $699.95. Dolby Digital-ready receivers were also seen in abundance, with street prices as low as $199.

Technics' SH-AC500D can decode both Dolby Digital- and DTS-encoded source materials for playback through an audio system with 5.1 discrete channels.

DTS, or Digital Theater System, is making some inroads in the home-theater market. DTS delivers six channels of master-quality audio. The DTS algorithm encodes six channels of 20-bit digital audio information into the space previously allotted for only two channels of 16-bit linear PCM. Then, during playback, the DTS decoder reconstructs the original six channels of 20-bit digital audio, said to be audibly superior to a CD's 16-bit linear PCM audio.

Dolby Digital is a standard audio type in the DVD-Video format, which means that all DVD players are DD-ready (although not all of them feature on-board Dolby Digital decoders, and not all DVD discs feature Dolby Digital soundtracks). DTS, on the other hand, is an option that is available to the developers of DVD discs.

Technics unveiled its SH-AC500D DTS/Dolby Digital Decoder, which, when connected to a DTS-ready source and an audio system with 5.1 discrete channels (left, center, right, left surround, right surround, and subwoofer), will deliver six channels of "sonic excellence" from any DTS-encoded DVD, Laser Disc (LD), or CD. A DD-ready sound system and a DD-encoded source are required to hear Dolby Digital material. The DTS/DD decoder will be available in May with a suggested retail price of $399.99.

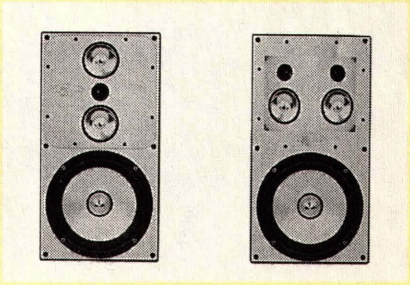
Meanwhile, the first DTS-capable DVD players were introduced at ICES 98. The DVD-890 from Marantz, for instance, can handle both Dolby Digital 5.1-channel soundtracks and six-channel DTS-encoded DVD, when the player is hooked up to a DD- and/or DTS-equipped receiver. (The first DTS-encoded DVDs are currently becoming available.) The DVD-890, with a suggested price of $699.99, will be shipping in the second quarter of 1998.

Also unveiled at ICES 98 were a variety of THX-certified Dolby Digital/DTS products—and Dolby Digital and DTS are credited with spurring the awareness, acceptance, and even sales of Home THX products. "As more and more Dolby Digital and DTS products come to market, it's interesting—and encouraging—to see that a growing proportion of those products are part of the Home THX Program," noted Marc Spector, director of marketing for the THX Division of Lucasfilm Ltd. "It certainly seems that manufacturers are responding to the growing sophistication of the home-theater market by further enhancing the sophistication of their products with THX Certification."

A small sampling of the new THX-certified products include DVD players from Denon, Meridian, Pioneer, and Runco, which showed a 200-disc DVD changer with PC-based controller; Dolby Digital/DTS-capable system controllers from Adcom, Audio Design Associates (ADA), Lexicon, Madrigal, McIntosh, and Meridian; an integrated Dolby Digital home theater system from Denmark-based Jamo, which includes six active speakers and a digital controller; and in-wall speakers from the newest THX licensee, Sonance.

In related news, Lucasfilm announced its intentions to introduce later this year a new set of THX certification standards that could be applied to mid-priced audio products. Spector said that the new standards, still in the development phase, might have a different logo than that carried by standard THX-certified products.

What if you want the home-theater experience without the fuss, the muss—or the alphabet soup? Two companies displayed "simple solutions" to home theater. Boston Acoustics' SoundBar Cinema places three speakers (right, left, and center) in a rectangular set-top box that also contains amplification, equalization, a Dolby Pro Logic Decoder, and Q-Sound processing, which widens the front image. A single separate speaker handles the surround channel. The SoundBar Cinema, with preprogrammed remote control, is available at a suggested list price of $799.



Sonance has joined the roster of THX licensees and is offering a pair of THX-certified in-wall home-theater speaker systems featuring polypropylene and aluminum cone drivers, plus a directable midrange/tweeter assembly.

Each of the two initial offerings in Pioneer's SimpleSolution HTV Series consists of a single slim-line unit that sits atop a TV and uses Virtual Dolby to create the illusion that specific sounds come from any point surrounding the listener. The main unit contains two high-power amplifiers that power two full-range speakers and a subwoofer. The HTV-1, with a 30-watt-per-channel amplifier and a 60-watt amp for the subwoofer, and a preset remote control, will be available in June with a suggested price of $429. The 40/120-watt HTV-2, with learning remote, will be available in September with a suggested price of $499.

DVD-AUDIO

During the 1998 ICES, the DVD WG-4 Audio Working Group announced that it had released a draft of its DVD audio specifications to DVD Consortium members, major music industry associations, the Recording Industry Association of America (RIAA), the Recording Industry Association of Japan, the International Federation of the Phonographic Industry, and WG-4 members. The Group hopes that feedback from those associations will help shape the final specifications for the DVD-Audio format, which will have to address copy-protection issues in a manner that is acceptable to the recording industry

You can enjoy DVD video on-the-go with Panasonic's DVD-L1 portable DVD player with built-in 5.8-inch widescreen LCD monitor.

Sharp's small-footprint DVD player is designed to go with the company's Dolby Digital minisystem.

as well as consumers.

WG-4's goal is to "create the music industry's next-generation format using the superior disc storage capacity of DVD." In contrast to the current DVD format, the audio specifications utilize the disc capacity by emphasizing improved next-generation digital sound quality rather than the playback of 135 minutes of video. When the specifications are finalized, DVD Audio will join DVD Video and DVD ROM as a "compatible family of formats."

DVD AND DIVX NEWS

DVD video hardware and software have been selling quite well for a new product category, although sales have not been as brisk as manufacturers had initially hoped. From last March, when they were introduced, through the end of 1997, manufacturers shipped more than 300,000 DVD players. It is estimated that 40% to 45% of those units were actually purchased, which means that about 125,000 U.S. households now have DVD players. For comparison's sake, 35,000 CD players sold in 1983, the first year they were on the market; VCRs were introduced in 1975 and the 200,000th unit sold in 1977.

At least a dozen manufacturers were exhibiting DVD players at ICES 98. Most showed second-generation units, although there were some new players in the DVD field, including Hitachi and Sharp. Some of the latest DVD players feature DTS-compatibility, others add virtual surround-sound enhancements to two-channel audio, and several offer component video outputs. There are also a couple of new DVD product categories: portables and changers.

Panasonic's DVD-L1 is a portable DVD player with a 5.8-inch widescreen LCD and built-in stereo speakers. It offers 10-bit video DAC and 96 kHz/24-bit DAC for linear PCM audio. Its rechargeable battery provides two hours of play time, and an included AC adapter allows it to be used as a home DVD player as well. Available this spring, the DVD-L1 has a suggested retail price of $1299.

Samsung calls its P-Theater "the world's smallest portable DVD player." We won't argue with that, considering it weighs in at two pounds and measures approximately 8 × 6½ × 2 inches. Resembling a portable CD player, the P-Theater comes with a headset viewer, similar to virtual-reality goggles, that is said to create the sensation of looking at a 40- to 70-inch screen. The P-Theater will ship later this year; no price has been announced.

Sharp's DVD-550 is not portable, but it is smaller than most. Designed as a companion piece to the company's Dolby Digital minisystem, mentioned above, it has a 270mm-wide footprint. The player has a built-in Dolby Digital decoder, and component-video and digital optical outputs. It will be available this spring at a suggested price of $749.

At the show, Runco debuted its THX-certified SAR-200, a 200-disc DVD changer that comes with the Runco Theater Manager, a single-zone controller for home multimedia systems. Compatible with CDs as well as DVDs, the SAR-200 is currently available at a suggested retail price of $14,995. A 60-disc DVD changer from Fisher will ship to the professional and institutional markets this fall, at a price that has yet to be announced.

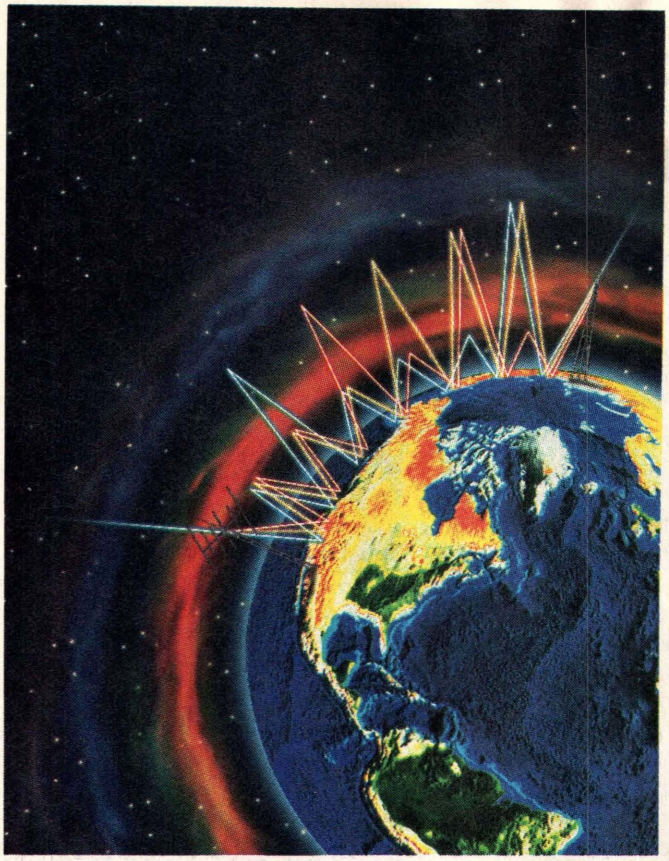
Also making news—and waves—at ICES 98 was Digital Video Express, a.k.a Divx. The company was at the show promoting its pay-per-view version of DVD, which is backed by Circuit City. Divx displayed prototypes in a nearby hotel suite, and manufacturers including Zenith, Panasonic, and Thomson announced plans to sell Divx players this year.

Divx DVD players are compatible with all DVD titles and CD audio discs, but Divx discs won't play on today's "open" DVD players. Divx movies will be available as rentals, costing between $5 and $7 for a 48-hour period, during which time they can be watched as often as you like. After that, you can keep the disc. But if you want to watch it again, you must pay for each additional 48-hour viewing period. An on-screen menu and on-board modem will allow you to order more time, and view your billing record, and will allow the authorization center to "unlock" the disk.

Said Divx chairman Richard Sharp, who is also the chairman of Circuit City, "Divx is a feature and not a format. A Divx player starts as a fully functioning DVD player, and adds this capability to it." It allows the consumer to "watch movies at home in a substantially different model," he added.

IT'S A WRAP!

All this talk of new technologies barely scratches the surface of the Consumer Electronics Show. Computers, communications, home-office products, accessories, mobile electronics, home theater, camcorders, and much more are all represented at the show. For a glimpse at the "best of the rest," see next month's Innovations '98 Wish List round-up. ■



A BEGINNER'S GUIDE TO RADIO PROPAGATION

How do radio waves get from here to there? In this article we will present some of the basic principles of RF propagation and give pointers on how you can use this information as a radio amateur or SWL.

KARL T. THURBER, W8FX

Have you ever wondered why a signal generated several hundred or thousand miles away reaches your location without the aid of connecting wires? After reading this article you should have a pretty good understanding of how and why this is possible. In addition to discussing basic radio propagation principles and techniques, we will also cover the electromagnetic spectrum; the nature of radio waves; the regions of the Earth's atmosphere; sunspots and how the sun affects propagation; radio propagation modes and parameters; VHF and UHF propagation modes; using propagation charts and making forecasts; the role of personal computers (PCs) in forecasting; and sources of solar, geomagnetic, and propagation indices and data. Before we get into propagation details, let's start with what constitutes the electromagnetic spectrum.

The Electromagnetic Spectrum. The radio spectrum extends from a frequency of a few hertz (Hz), or 10^8 meters in wavelength, to about 300 gigahertz (GHz), or 1 mm (10^{-3} m). That is but a small part of the total electromagnetic spectrum, which extends to about 1 attometer (10^{-18} m), or a wavelength of one-quintillionth of a meter. Figure 1 shows the total electromagnetic spectrum in terms of increasing wavelength (or decreasing frequency).

Frequency-wise, those frequencies in the lowest portion of the spectrum (ranging from zero to 3 Hz) are known as ultra-low frequencies (ULF). Just above ULF lies another band called extremely low frequencies (ELF), which cover a range of 3 Hz to 3 kHz. Above that grouping, ranging from 3 kHz to 30 kHz, is the very low-frequency (VLF) range. Next are the low frequencies (LF), from 30 kHz to 300 kHz. The medium frequencies (MF) extend from 300 kHz to 3000 kHz (3 MHz).

From 3 MHz to 30 MHz are the high frequencies (HF). Above HF are the very high frequencies (VHF), from 30 MHz to 300 MHz. The ultra-high frequencies (UHF) extend from 300 to 3000 MHz, or 3 GHz. From 3 GHz to 30 GHz are the super high frequencies (SHF), and from 30 GHz to 300 GHz, the extremely high frequencies (EHF).

In this article, we'll be concerned with but a small portion of the total electromagnetic spectrum—covering long wave (LF) through the AM broadcast band and medium wave (MF), shortwave, VHF and UHF, and the microwave frequencies (low end starts at about 1 GHz).

The Fundamental Nature of Radio Waves. Radio communication is accomplished via electromagnetic waves, which travel through the Earth's atmosphere. Like light, radio waves are propagated as electromagnetic radiant energy.

Reflection, refraction, and diffraction, or some mix thereof, play an important role in radio-wave propagation. Reflection can occur at any boundary between materials with a different dielectric (non-conducting) constant. Radio waves can be reflected by ionized atmospheric layers, buildings, air mass boundaries, water, or the ground. Atmospheric reflection plays a large part in communication. Without an atmosphere, such as on the Moon or on other planets, we would not be able to enjoy the type of radio propagation we currently experience.

Refraction—the bending of radio waves as they pass at an angle from one medium to another—is common at boundaries between air masses; it is particularly noticeable at VHF, UHF, and microwave frequencies.

The term diffraction refers to the irregular spreading of waves due to interference of one part of the wave with another part. It also describes a change in the direction and intensity of radio waves as they pass by an obstacle or aperture. Diffraction is related to scattering—a "disordered" change in the direction of propagation when waves encounter matter, something like what happens when light tries to penetrate fog.

A practical way to classify radio waves is by propagation: ionospheric, tropospheric, or ground waves. Ionospheric waves (also known as sky waves) make up most of the transmitted electromagnetic radiation. HF radio waves are propagated as sky waves or ground waves, or a combination of both modes. Sky waves reflected from the ionosphere can traverse great distances, and enable global communication. Ground wave refers to signals that travel close to the Earth (though not necessarily touching it) and do not leave the lower atmosphere. Ground waves, which can include waves that follow the Earth's curvature by bending in the lower atmosphere or troposphere—a propagation form known as tropospheric bending—are not very useful for long-distance communication because they are greatly attenuated if they travel more than few dozen miles.

The term surface wave often is considered synonymous with ground wave, but, strictly speaking, the surface wave is a wave that travels in contact with the Earth's surface. Because of high attenuation, its propagation range is limited to about 100 miles or so, depending on wavelength and several other factors. Since attenuation increases with frequency, surface waves are of little value on HF. Such waves are most useful for low- and medium-frequency transmissions, such as the standard AM broadcast band.

The Earth's Lower Atmosphere. The Earth's atmosphere is the body of air surrounding the Earth, reaching elevations of more than about 500 statute miles. The atmosphere is divided into several regions or layers—the troposphere, stratosphere, and ionosphere. (There are other layers, but those listed are the ones with which we are most concerned.) Beyond the ionosphere lies the magnetosphere, as shown in Fig. 2. (All distances and distance conversions listed are approximate.) For the moment, we will concern ourselves with only the two lowest regions; the troposphere and the stratosphere.

The troposphere—which lies between the surface of the Earth and the tropopause (the region that separates the troposphere from the stratosphere and varies in height from about 5 miles at the poles to 11 miles at the equator)—is the lowest layer of the atmosphere. The troposphere plays a major role in VHF and higher frequency propagation. Immediately above the troposphere lies the stratosphere, a relatively calm region of the atmosphere that is located from about 5–30 miles above the Earth's surface. The stratosphere shows little temperature change throughout its height. About 99 percent of all atmospheric gases are found within the troposphere and the stratosphere.

The Upper Atmosphere. The ionosphere is divided into three major regions or layers: D, E, and F, in order of increasing altitude and electron density. Each layer plays a distinct role in ionospheric propagation, and each reflects or refracts radio waves depending upon the frequency and angle of arrival of the incident energy. The two lower layers of the ionosphere, the D and E regions, are absorbing layers, while the F layers are reflecting layers. The D layer—whose electron density is under direct solar control and in proportion to the sun's height or zenith angle—forms at from 30 to 55 miles above the Earth in daylight. The D layer peaks at about noon and mostly dissipates after sunset; it is also higher in summer than in winter. The D layer absorbs energy at the low end of the HF spectrum. The signal-strength reduction can be considerable,

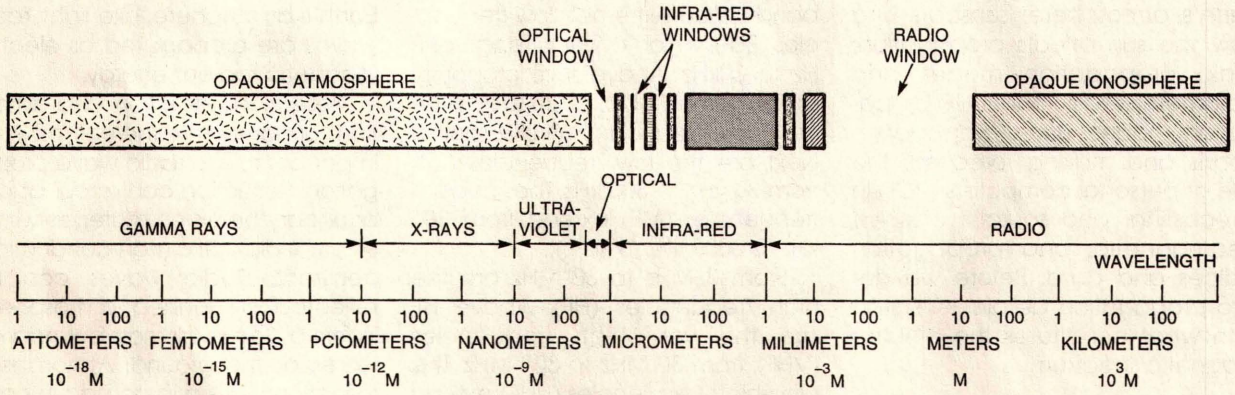


Fig. 1. The electromagnetic spectrum is an array of radiant energies. In order of increasing wavelength (smallest to longest) or decreasing frequency (highest to lowest), the types of electromagnetic radiation are gamma radiation, x-rays, ultraviolet radiation, visible light, infrared radiation, microwaves, and radio waves. The illustration shows the total spectrum in terms of wavelength and depicts the atmosphere's relative transparency—very important in understanding propagation concepts.

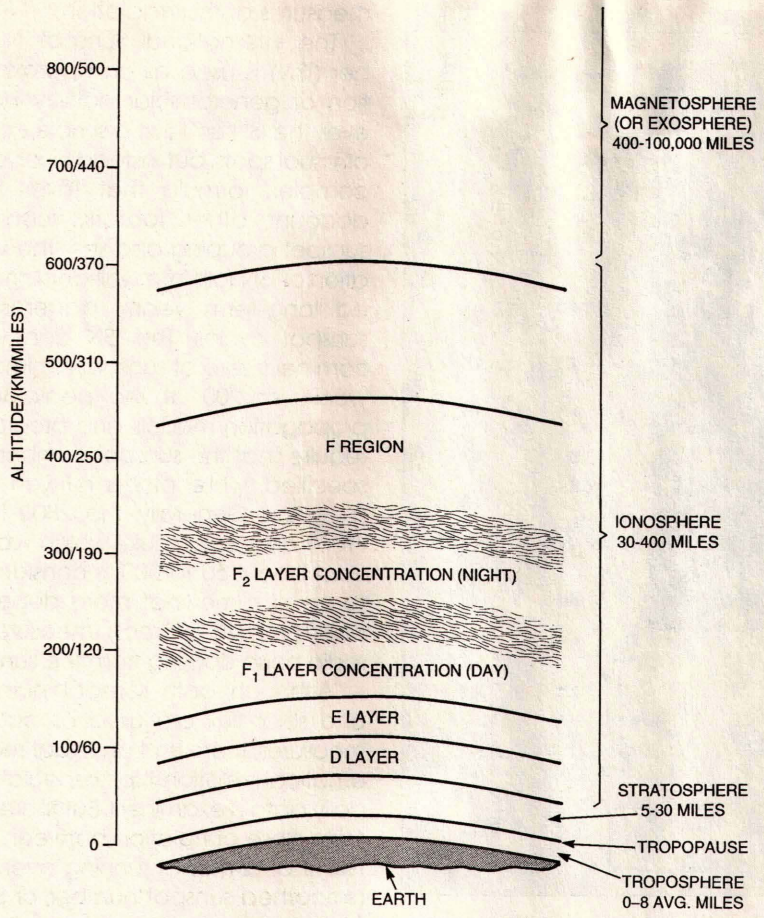


Fig. 2. Depicted here are the major regions of the Earth's atmosphere—ranging from the troposphere (the lowest region) through the stratosphere, ionosphere, and magnetosphere.

especially during daytime.

The E layer—the lowest layer that can refract HF signals—develops during the day at between about 60 to 70 miles above the Earth. It, too, is under strong solar control, with its ionization density reaching its maximum after noon and falling to a low nighttime level after sunset. However, the E layer does not completely disappear at night. The E layer has daily and seasonal variations that are similar to those exhibited by the D layer. Signals can propagate between two points via the E layer, as they do via the F layers. However, the maximum ground distance in one E-layer hop is only about 1200–1300 miles. Thus, more hops are usually required on DX paths. The DX, or long-distance HF communication, often is the result of both the F and E layers getting into the act in a variety of "mixed" propagation modes.

At elevations ranging between about 130 and 260 miles above the Earth's surface, the F layer is the highest ionospheric region. Long-distance HF communication is most influenced by F-layer ionization. In the daytime, the F layer splits into two parts: F_1 (at roughly 140 miles), and F_2 (at about 200 miles). At night and during the wintertime, the F_1 and F_2 layers recombine into a single F layer.

The F_1 layer, like the E layer, is under strong solar control and reaches maximum ionization about an hour after noon. When the F_1 region exists as a separate layer, its propagational effects are similar to those of the E layer. The F_2 layer is the highest layer. It usually has the highest electron density and is of great value in HF ionospheric propagation, but it is characterized by much variability. The height of the F_2 layer and its density depend on a variety of factors, including local time, season, sunspot cycle, latitude, and longitude. The maximum electron density of the F_2 layer usually occurs well after noon, sometimes even in the evening. The layer decays slowly at night. At mid-latitudes, the height of maximum electron density is higher at night than in the daytime, while at equatorial latitudes, the opposite occurs. The maximum Earth distance of one F_2 layer hop is about 2500 miles, readily enabling global communication via multiple hops.

While we're most concerned with the ionosphere, let us not forget what lies beyond—the magnetosphere, at roughly 400 to 100,000 miles above the Earth. This shell is an asymmetrical magnetic envelope which shelters the Earth from solar wind (a stream of ionized particles ejected from the Sun at high speeds) by deflecting it into space. The ionosphere lies closer to the Earth, but there is considerable coupling (both electric and magnetic) between these two layers.

How The Sun Affects Propagation. Solar dynamics have everything to do with propagation, just as they have a great deal to do with everything on Earth. The density and nature of the ionosphere is directly dependent on the amount of solar radiation that reaches the Earth. Sunspots are the sun's easiest-observed characteristic. (You may even have seen these dark spots or blemishes that appear periodically in groups on its surface.) They are probably caused by intense, localized magnetic fields trapped below the sun's surface. Sunspots are the source of flares, which are violent solar events that produce a variety of radiation, including high-energy particle cosmic radiation, low-energy particle radiation, and electromagnetic radiation, each of which has an effect on propagation.

Since the earliest days of observing solar activity, our measure of that phenomena has been based on counting sunspots. Radio propagation conditions vary with sunspot number and size, affecting both maximum usable frequency (which is the upper frequency at any given time for which a particular propagation path is possible) and signal absorption (which increases as the ionizing radiation increases). The sunspot number and solar flux are used as indirect

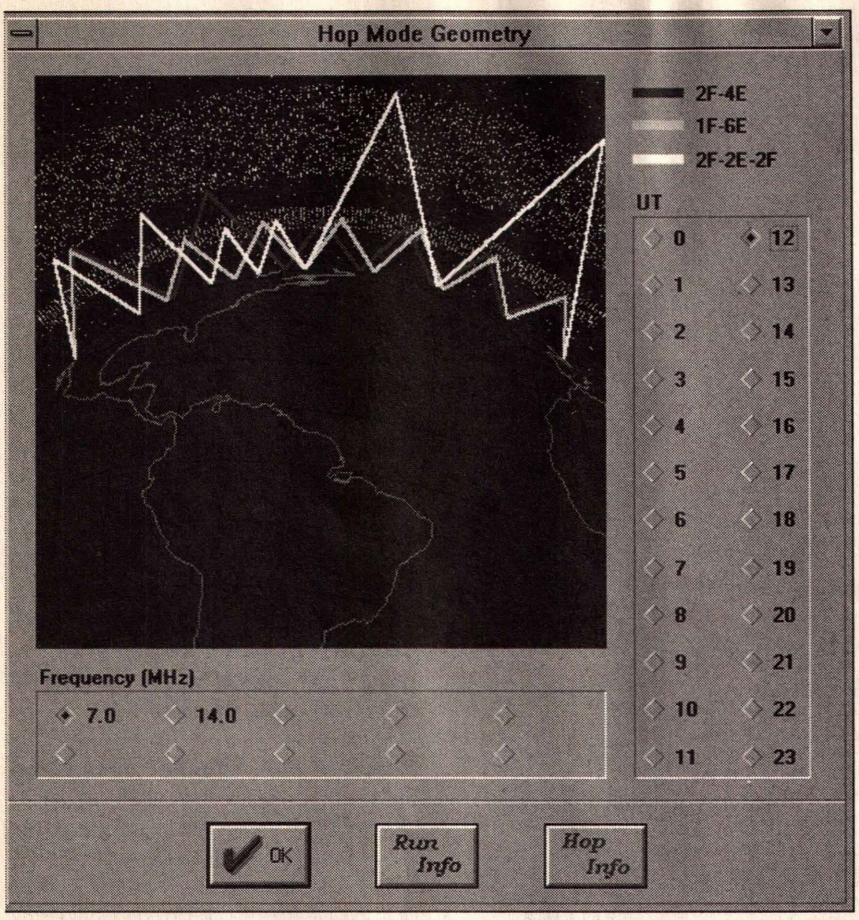


Fig. 3. Pacific-Sierra Research's HFx is a popular Windows HF propagation prediction program. The HFx Hop Mode model generates field strength, mode, availability, and signal-to-noise ratio (S/NR) for a given date, transmitter and receiver pair, frequency, and antenna type. The program displays the data in several formats, including a graphic of sky wave ionospheric hops for each frequency at one-hour intervals, as shown here.

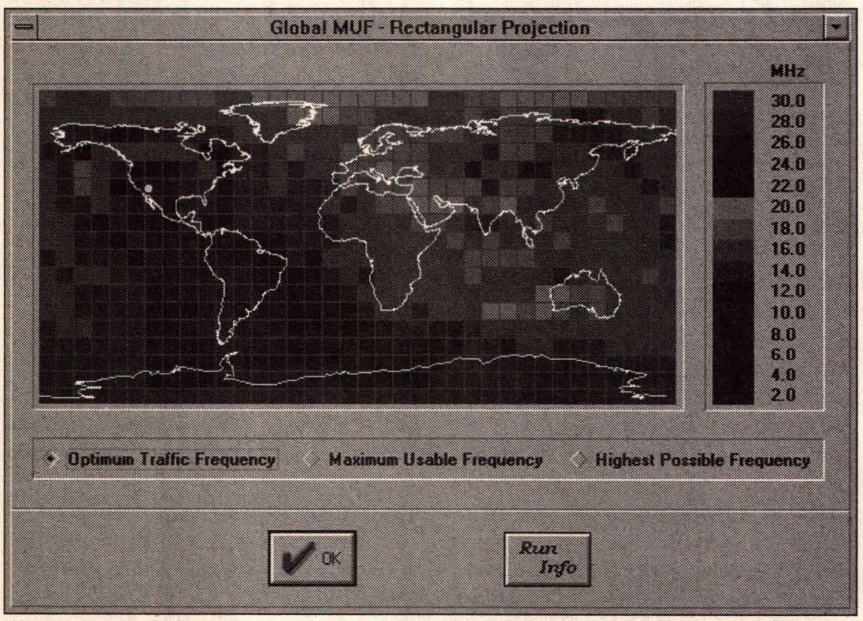


Fig. 4. The HFx Global MUF model generates a color map of Maximum Usable Frequency (MUF), Frequency of Optimum Traffic (FOT), or Highest Possible Frequency (HPF). Using this model, you can determine the best frequencies to reach any part of the world. Global MUF geometry is depicted here on a rectangular projection.

measures of that radiation.

The International Sunspot Number (ISN) is used as an approximation of general solar activity. However, the ISN isn't just a simple count of visual spots, but instead involves a complex formula that takes into account other factors, such as sunspot grouping and size. The variation of ISN falls into well-documented long-term yearly patterns or sunspot cycles. The ISN can vary from near zero at sunspot minima to well over 200 at the peak. Most propagation models and programs require that the sunspot number be specified, while others let you use solar flux. Generally, the 2800 MHz (10.7 cm) solar flux, which varies from about 60 to 300, is considered to be a somewhat more dependable (yet still indirect) measure of radio noise coming from the sun.

Although both sunspot number and solar flux are used as activity measures, there isn't an exact mathematical relationship, especially if daily data is examined. But there is a fairly close correlation between the two if a 12-month running average (smoothed sunspot number, or SSN) for both sunspots and solar flux is used. Episodes of solar activity have a number of terrestrial effects. Ionospheric propagation is susceptible to several kinds of short-term disturbances, which upset the ionospheric electron configuration, thereby affecting propagation. The disturbances weaken signal levels and, in some cases, make them disappear entirely. A sudden ionospheric disturbance or SIDs—which can last from just a few minutes to several hours—or shortwave fadeout (SWF) occurs when x-rays emitted by a solar flare reach the sunlit portion of the D layer, increasing the electron density and absorption rate of that layer.

An event known as Polar Cap Absorption (PCA), caused by high energy protons from large solar flares, occurs as a result of intense ionization of the polar ionosphere. PCAs, which begin about 15 minutes to several hours after protons are ejected from the Sun, may last from about an hour to 60 hours or more. Ionospheric storms are caused by a variety of solar phenomena, such as coronal holes, coronal mass ejections, and solar flares. The storms last

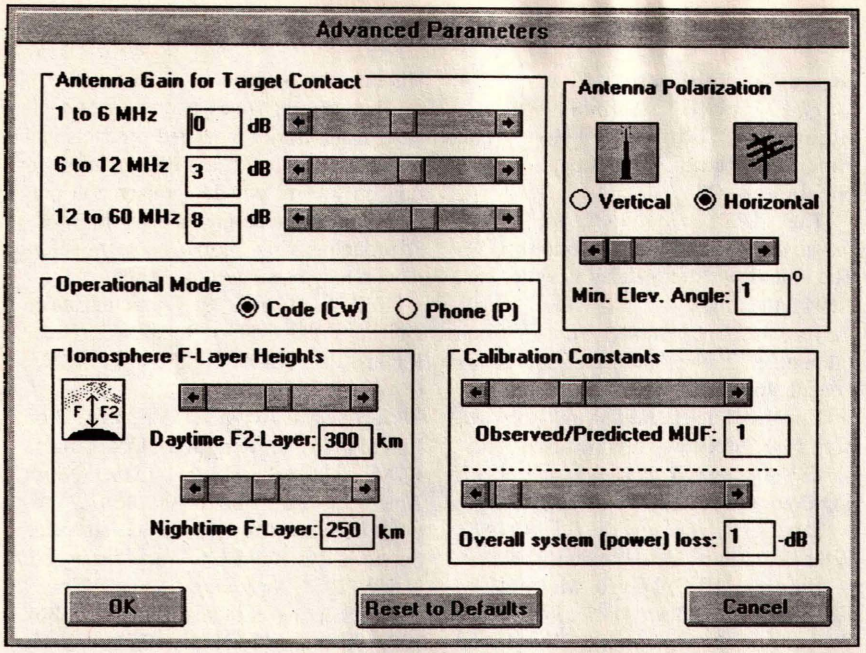


Fig. 5. SKYCOM 2.0, from Fuentez Systems Concepts, Inc., is an easy-to-use Windows program that presents a "quick-look" prediction for "yes-no-maybe" contact possibilities; you can also obtain a detailed report. Shown here is the Advanced Parameters Window, where you can fine tune the program to better reflect prevailing conditions or set up "what if" scenarios.

from a few hours to several days, and some disturbances recur in step with the Sun's 27.5-day rotation on its axis. Although ionospheric storms are difficult to predict, they occur in conjunction with geomagnetic storms, so geomagnetic field disturbances are an indicator of ionospheric disturbances. Severity is indicated by the A and K indices included in the geophysical alert (Geoalert) broadcasts from the National Institute of Standards and Technology (NIST) radio stations WWV and WWVH. In general, maximum usable frequencies or MUFs decrease and absorption increases as geomagnetic field activity increases. Ionospheric and magnetic disturbances may be accompanied by visible auroras. Solar radiation is not constant by any means. There are both relatively short- and long-term solar cycles that must be dealt with.

Sunspot Cycles. The first solar cycle is short-term, based on the sun's own approximate 27.5-day rotation period, which can be observed visually by noting the periodic appearance of sunspots on the surface. Generally, sunspots reappear every 27.5 days, so that ionospheric propagation conditions tend to recur with that cycle. Since both geomagnetic activity and solar flux reflect the rotation period, you can make good short-term predictions for up to about a month in advance.

The number of sunspots reaches a maximum every 11 years (10.7 years to be precise), although the period varies from about 7 to 17 years. Cycle 19, which peaked in 1958, was the highest cycle recorded, with an average SSN of over 200. Experts generally agree that we passed through the trough or low point between Cycle 22 (which began in September 1986) and the current dawning Cycle 23, in mid-1996. Presently sunspots are again beginning their awaited climb, and DX conditions are starting to improve.

Long term predictions, such as deciding when a sunspot cycle has ended and another has begun, or even forecasting next year's conditions, is problematic. Doing so is a complex scientific endeavor that involves a variety of sophisticated techniques, all of which are beyond the scope of this article. Luckily, forecasting the next day's, week's, or month's radio conditions isn't all that difficult. The task has been simplified by easy-to-use propagation charts in popular radio journals, as well as some excellent computer software developed for that purpose.

High Frequency Communications. Most long-distance HF communication depends on the bending (refraction) of waves in the ionosphere, which consists of ionized regions caused by the Sun's x-ray and UV radiation. That ionization is intense enough to affect the properties of electromagnetic waves propagated through it. Upon entering the ionosphere, HF waves are refracted in proportion to the layer's ionization and the signal's wavelength. If the ionization is large enough, waves reaching the ionosphere are bent back toward the Earth as if they had been reflected, thereby enabling distant reception. However, there is a maximum frequency, at a given elevation angle, for which a transmitted signal will be refracted back to Earth. Higher frequencies, at the same elevation angle, penetrate this layer and may travel into space.

The highest frequency at which a wave is returned to Earth at vertical incidence (at ninety degrees or zero ground distance) is known as the vertical incidence critical frequency (or simply critical frequency). For communication between two points on Earth, vertical incidence serves no purpose—oblique propagation is necessary, and this method is directly related to the critical frequency. At transmissions above the critical frequency, the steepest angle at which a signal is reflected back to Earth is called the critical angle. Signals transmitted at angles greater than the critical angle pass through the ionosphere and *do not* return to Earth. Thus, depending on the critical angle and signal frequency, there is some distance beyond which there are no signal return, hence no sky wave. The area between the limit of ground wave range and the innermost edge of signal returned from the ionosphere is called the skip region (also known as the skip zone or dead zone), since sky wave signals simply skip over it.

The length of the skip zone is the skip distance—*i.e.*, the shortest distance that can be reached by a refracted wave at a given frequen-

cy, or the distance between the transmitter site and the ionospheric signal return. To reach shorter distances, you must use lower frequencies, although the signal may be heard weakly within the zone due to scattering effects.

Radio Propagation Modes and Parameters. Signals can travel from transmitter to receiver by one, two, or multiple hops. Propagation configuration modes can involve one or more F-layer (F_2) hops, one or more E-layer hops, or a combination of the two, with a ground reflection between adjacent hops. If the wave simply is reflected midway between points, it is referred to as one-hop mode. Two-hop mode is when the signal is reflected twice by the ionosphere and once by the ground. The reflecting layer can be the F_2 or the E layer—the E layer often is ionized sufficiently to reflect waves at low frequencies. Over long distances, different ionospheric conditions exist at each reflection point, so multiple hops can be quite complex.

Multihop paths that span the day/night boundary often involve a combination of E- and F-layer reflections, and are referred to as either F-layer modes, E-layer modes, or mixed modes. Recall that the maximum single-hop F_2-layer distance is about 2500 miles, while E-layer reflection is about 1250 miles; longer paths require multiple hops.

The range of frequencies that support communication between two particular points are of great interest to radio amateurs and shortwave listeners (SWLs). The MUF—which is influenced by absorption, transmitter power, antenna gain, receiver characteristics, type of service, and noise conditions—is the highest frequency at which a radio wave can propagate between two points at a given time by ionospheric refraction alone. Because of the great variability in the Earth's ionosphere, predicted MUFs on a given path aren't absolute values; rather, they are statistical. Predicted MUFs are median values: the actual value exceeds the predicted MUF 50 percent of the time; the other 50 percent of the time, it is less than that predicted. In general, transmission just below the MUF for a particular

FOR MORE INFORMATION

Suggested Readings

The ARRL Antenna Book, Eighteenth Edition, 1997. The American Radio Relay League, Inc., Newington, CT.

The ARRL Handbook for Radio Amateurs, Seventy-Fifth Edition, 1998. The American Radio Relay League, Inc., Newington, CT.

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NIST Special Publication 432, *NIST Time and Frequency Services*. Boulder, CO. Time and Frequency Division, National Institute of Standards and Technology, June 1991.

NISTIR 5042-2, *NIST Time and Frequency Bulletin*. Boulder, CO: Time and Frequency Division, National Institute of Standards and Technology, February 1996 (published monthly).

NOAA Technical Memorandum ERL SEL-80, *A Radio Frequency User's Guide to the Space Environment Services Center Geophysical Alert Broadcasts*. Boulder, CO. Space Environment Laboratory, June 1990.

Pocock, Emil, W3EP. *Beyond Line of Sight: A History of VHF Propagation from the Pages of QST*, 1992. The American Radio Relay League, Inc., Newington, CT.

Thurber, Karl T., Jr. "Long Delayed Echoes: Fact or Fancy?" **Popular Electronics**, August 1995.

Names and Numbers

Here are the names, addresses, and telephone numbers for related products and services. Also included is contact information on several popular propagation prediction software programs (note the several programs with similar names)—information may be subject to change.

Collins Avionics & Communications Division, 350 Collins Road N.E., Cedar Rapids, IA 52498. Tel. 800-321-2223. (*PropMan* program).

Jacques d'Avignon, VE3VIA, 965 Lincoln Drive, Kingston, ON Canada K7M 4Z3. Tel. 613-634-1519. (North American distributor for the *ASAPS* program developed by IPS Radio and Space Services, P.O. Box 5606, West Chatswood, N.S.W. 2057, Australia).

Engineering Systems, Inc., P.O. Box 939, Vienna, VA 22180. Tel. 703-687-3000. (*Skycom*. DOS-based program).

Fuentez Systems Concepts, Inc., 11781 Lee Jackson Highway, Suite 700, Fairfax, VA 22033. Tel. 800-989-1447. (*SKYCOM 2.0*. Windows-based program).

Kangaroo Tabor Software, Rt. 2, Box 106, Farwell, TX 79325. e-mail: ku5s@wtrt.net. Web: *www.wtrt.net/~ku5s*. (*Wizard2*.Communications analysis prediction).

Pacific-Sierra Research Corporation, 2901 28th Street, Santa Monica, CA 90405. Tel. 800-820-4PSR. Web: *www.psrv.com/hfx/*. (*HFx* program).

Skywave Technologies (Jacob Handwerker, W1FM), 17 Pine Knoll Road, Lexington, MA 02173; Tel. 617-862-6742. (*IONSOUND* and *IONSOUND PRO* programs).

W6EL Software, Sheldon C. Shallon, 11058 Queensland St., Los Angeles, CA 90034. (*MINIPROP PLUS* program).

Xantek, Inc., P.O. Box 834, Madison Square Station, New York, NY 10159. Tel. 212-566-8240. (*Super DX EDGE* grayline computer program and slide rule based grayline calculator).

Websites

http://solar.uleth.ca/solar/—Solar Terrestrial Dispatch (in Canada), home page

www.dxlc.com/solar—for various solar activity reports (courtesy DX Listeners Club of Norway)

www.ngdc.noaa.gov—National Geophysical Data Center

www.sel.noaa.gov/—Space Environment Center

Also check numerous programs found on assorted ham-related bulletin boards.

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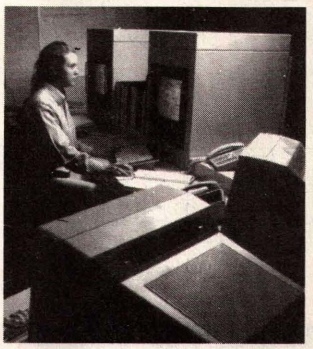
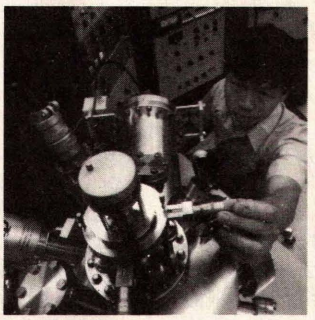


Computer Programming



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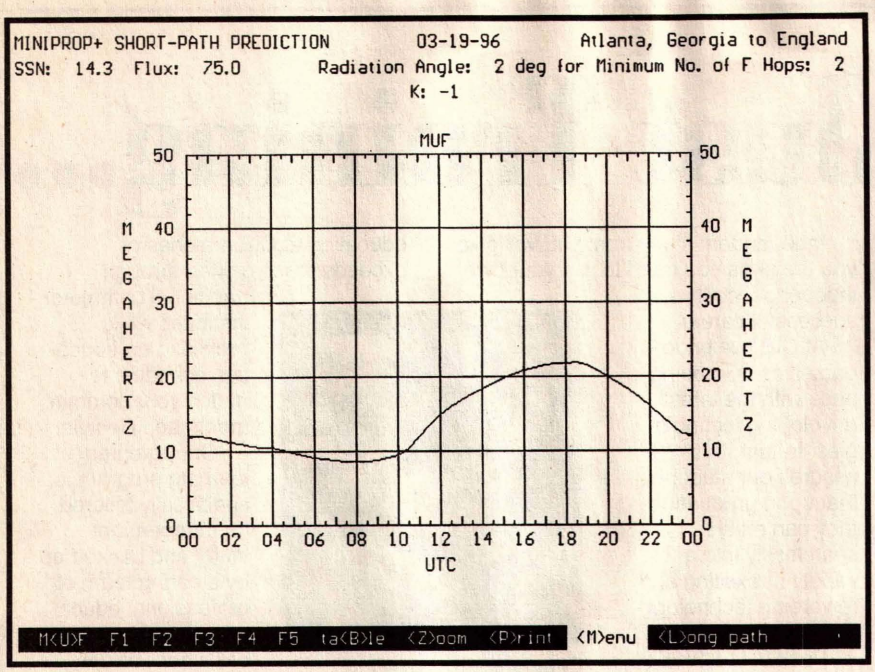
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SSN: 14.3 Flux: 75.0 Radiation Angle: 2 deg for Minimum No. of F Hops: 2
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Fig. 6. MINIPROP PLUS 2.5 has significant graphical capabilities. Shown here a display of predicted MUF with a resolution of 30 minutes. The prompt line selections on the graph screen also allow you to view a graph of predicted signal levels or signal-to-noise ratio (S/NR) on each prediction frequency.

path produces the strongest signals. But for long paths, the true feasibility of communication is determined mainly by the MUFs of hops close to the transmitter and receiver. The MUF for the entire path is the lowest MUF.

There are also lower limits to useful communications frequencies over a given path. The lowest usable frequency (LUF)—which is determined by many of the same types of factors that govern the MUF—is the lowest frequency that is effective for ionospheric propagation between two points. If the LUF exceeds the MUF, you have a "radio blackout" and will probably be unable to maintain communication over the path.

The highest possible frequency (HPF) is often given in addition to the MUF. The predicted frequency supported by the ionosphere is higher than the predicted MUF 10 percent of the time. Ninety percent of the time the predicted frequency is lower than the MUF and is called the frequency of optimum traffic (FOT).

Unusual HF Propagation Modes. Here you have the basic modes of propagation; however there are some unusual propagation phenomena—such as F-layer grayline and long path propagation, nonreciprocal communication, ionospheric fading, auroral propagation, backscatter, sidescatter, and ducting, to name just a few—that may be encountered.

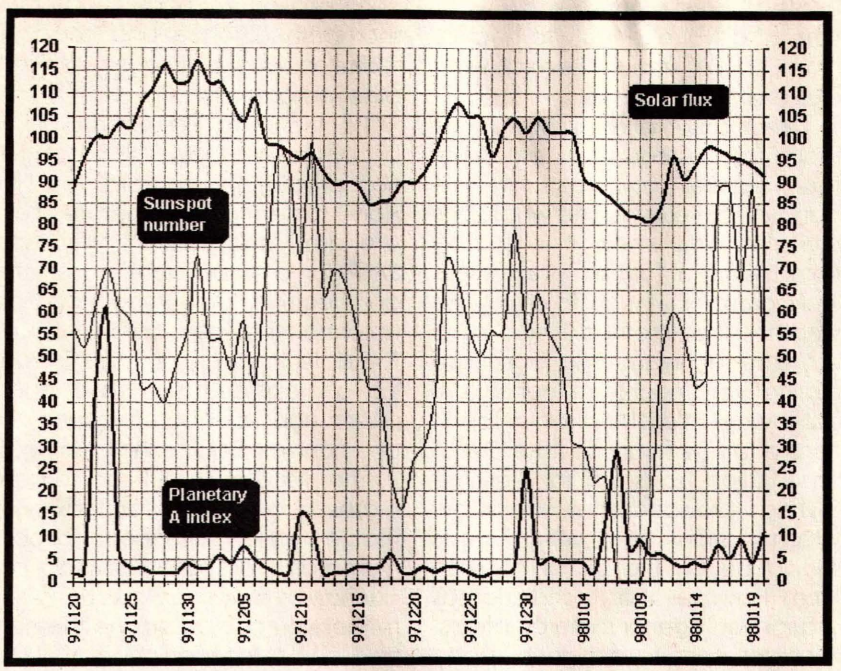
F-layer grayline propagation is a special form of propagation surrounding the unusual ionospheric configuration along the fuzzy "twilight zone" between day and night. The grayline (terminator), which generally runs north-south but can vary, extends completely around the Earth. Grayline propagation is very efficient, so it can be one of the best HF-communication modes, even with low power transmitters and modest antennas. However, at any given location, grayline conditions exist for only about two hours a day: when one station is in sunrise and the other in sunset (or *vice versa*)—one hour in the morning (plus and minus 30 minutes from sunrise) and one hour in the evening (plus and minus 30 minutes from sunset).

Usually, long-distance HF communication takes place along the shortest great circle path (the "short path") between points, which is always less than about 12,400 miles, or half the Earth's circumference. But you can sometimes make contact in the opposite direction, the long way around the Earth ("long path"). Although the great circle distance traveled by the radio waves may be longer, the absorption is less (due to the path traveled being in darkness). That type of propagation can be useful if the short path isn't open for communication. However, when both paths are open at the same time, you may hear an echo in the received signal due to the phase differences between the paths traveled by the incoming waves.

Normally, radio propagation is a two-way street. But because of atmospheric anomalies, especially differences in the junctions between ionospheric layers at the path ends, it is possible for signals to travel only one way over the path; that phenomena is called non-reciprocal communication, or one-way skip. It is more common to have a significant difference in signal strength at one end of the path, rather than the complete absence of the signal.

Ionospheric fading is the variation in signal strength caused by a gradual change in the nature of the transmission medium, where signals rise and fall over a few seconds to a few minutes. That phenomenon is usually caused by the interaction of several radio waves from the same source arriving (essentially out of phase) via different propagation modes. Stronger signals result from radio waves that arrive in phase and thus combine, while weaker signals are a result of out-of-phase signals arriving together. A variety of ionospheric phenomena can cause fading. Even signals arriving over a single path can fade due to changes in the ionospheric medium over the path.

Auroral propagation (aurora) is caused by sudden outbursts of solar activity wherein particles are ejected from the Sun. Some of those particles reach the Earth's atmosphere about 24 to 36 hours later, where they are channeled to the polar regions by the Earth's magnetic field. That causes a reaction with the Earth's magnetosphere and its magnetic field. The upshot often is a visible auroral display (the northern and southern lights) as well as a radio aurora—a sort of fluorescence of the E layer which tends to reflect radio signals above about 20 MHz.



*The solar terrestrial activity report (updated January 21 1998 at 0410 UTC)—downloaded (*www.dxlc.com/solar*) partially from data of the Sunspot Index Data Center in Brussels, and reproduced courtesy of Jan Alvestad.*

Backscatter—the scattering of a signal at the point where the ionospherically propagated signal arrives—helps to fill in skip zones. Sidescatter is similar, but the groundscatter zone is somewhat off the direct line between the two stations. Both effects are particularly noticeable on the amateur 10-meter (28-MHz) band.

Ionospheric and magnetospheric ducting also may occur. In ionospheric ducting, signals may even become trapped in a duct (similar to a waveguide), possibly between the E and F layers, perhaps circling the world several times, traveling from one end of the ionospheric duct to the other. That phenomenon may be a major cause of so-called "Long Delayed Echoes" (LDEs) on HF signals. Ducting on VHF, UHF, and microwave signals may occur in the magnetosphere, rather than in the ionosphere, which largely is transparent to such higher frequencies.

VHF and UHF Propagation Modes. At one time people believed that communication on VHF and higher frequencies would be strictly line-of-sight, but that belief has been proven wrong. Many tropospheric and ionospheric modes and phenomena tend to make VHF and higher frequency propagation very exciting. Certain weather conditions can cause tropospheric refraction, producing greatly increased VHF and UHF signal coverage, and stronger signals than expected. The tropospheric phenomenon known as ducting takes place when refraction is so high that radio waves are bent back to the Earth. Ducting tends to occur when weather conditions involving temperature inversions are present.

All radio waves propagate at least partly through the troposphere, where they are subject to refraction, scattering, and other phenomena. While tropospheric conditions usually are not very significant below about 30 MHz, they're quite important at VHF and higher frequencies. You'll find a common but highly significant form of tropospheric propagation to be tropospheric scatter, sometimes called troposcatter. In fact, most VHF communication beyond the radio horizon out to about 300 miles is the result of signal scattering in the troposphere. One of the best features of troposcatter is that it is present most of the time, and it doesn't necessarily require special equipment—although high-gain directional antennas and high transmitter power are helpful.

The ionosphere's layers are most important at HF, but some ionospheric irregularities and modes are significant at VHF, especially in the range 30–100 MHz. One of these is D-layer ionospheric forward scatter. That mode is fairly uncommon and usually causes weak signals, but it can produce VHF communication of up to about 1000 miles. It is most noticeable when other forms of propagation aren't present.

Embedded at times within the E layer is the sporadic-E layer—an anomalous ionization layer that is sometimes patchy and irregular and, at other times, as smooth as silk. Many experts believe that intense sporadic-E ionization is caused by wind shear. Sporadic-E layer properties vary greatly with latitude and time of day. "Short-skip" openings on the amateur 6- and 2-meter bands often result from one-hop sporadic-E ionization.

Another E-layer propagation phenomenon is auroral E, which is noticeable on the amateur 28-, 50-, and (sometimes) 144-MHz bands. It is common across the northern third of the US and southern Canada at about the same time as auroral activity is diminishing. Signals, much like sporadic-E, sometimes have a "hollow" sound. Effects are found mostly on east-to-west paths over distances up to about 1400 miles. Auroral E openings usually last for an hour or two.

F-layer trans-equatorial spread-F, sometimes known as trans-equatorial (TE) propagation—possibly due to irregular "bulges" in the F_2 layer near the equator—can result in signals propagating between 3100 and 5000 miles across the equator; the signals tend to move westward with the setting sun. The effects have been noticed as low as the 10-meter amateur band and as high as 432 MHz. Trans-equatorial signals have a rough, auroral character, sometimes called "flutter fading," which some texts describe as trans-equatorial field-aligned irregularities.

Large numbers of meteors, or "shooting stars," enter the atmosphere every day. The number increases at certain periods of the year during "meteor showers." The larger meteors leave a long, ionized

trail behind them, especially prominent in the E layer, which allows the reflection or scattering of VHF signals. Meteor-burst openings affect VHF to 200 MHz signals or higher traveling at altitudes between 300 and 1450 miles. You'll find meteor scatter contacts usually very short. It is not too difficult to literally bounce VHF and higher frequency signals off the moon (over what are known as Earth-Moon-Earth, or EME paths) across a wide range of VHF, UHF, and microwave frequencies. In fact, it's been done by amateurs since 1960 (1953 if you count "one-way" EME echoes of an amateur's own signals). Since the moon reflects only a few percent of the signal that reaches it, high-power and high-gain antennas on both ends generally are needed for success.

Using Propagation Charts And Making Forecasts. All this knowledge is little more than academic esoterica unless you have some idea of how to convert theory into practice. Amateur-radio operators, SWLs, VHF/UHF scanner buffs, and others are all interested in predicting ionospheric radio conditions. An easily-obtained solar flux or sunspot number is all that's needed to plug into a propagation prediction program to see when and if the band(s) will be open to a given location. Some like to keep up with expected conditions via the propagation column of their favorite amateur radio magazine. Still others like to have the raw data to "roll their own" propagation estimates.

However, predicting propagation conditions is something like predicting the weather—it is not an exact science. Particularly daunting is that the underlying phenomena and relationships are complex and involve many variables. Experience and a knowledge of predicted and actual propagation conditions are required to make realistic and useful forecasts.

Luckily most of us focus on practical, short-term forecasting, since it's impossible to accurately predict propagation conditions far ahead. We're interested in whether today or this week or this month is going to give us conditions good enough to warrant participating in a DX radio contest, or we want to know what time of day we're likely to hear or "work" a DX station. Several vehicles exist for doing this.

Direct observation, although not really forecasting, is a technique that requires you to scan the band(s) of interest to see what DX is rolling in, and where it is coming from. It is similar to the meteorologist looking out his window to check the weather. That method is fine as a real-time technique and for extrapolating very near-term conditions, but reveals little about radio conditions in a few hours or days. Direct observation works well for real-time SWLing (provided that you know which stations from which areas should be on the air at a given time). However, that technique has a disadvantage for radio amateurs. For hams, conditions might be open to particular areas of the world, but no one is transmitting from them. Thus a band may appear "dead" when it's really just dozing.

A more polished form of direct observation involves systematically scanning known operational HF beacon stations in various areas of the world. A variety of organizations operate beacons, which are mostly clustered on the 10- and 20-meter amateur bands; many are on 6 meters. For example, the Northern California DX Foundation (NCDXF) operates a network of beacons on 14.100 MHz in the 20-meter band, and the International Telecommunication Union (ITU) operates beacons in Australia and Norway on frequencies adjacent to several HF amateur bands.

Using Computers In HF Propagation Prediction. Until recently, radio hamshack and SWL PC software was focused mainly on QSO (contact) and contest logging. Today, however, software has been developed that lets your PC perform many other chores, and most can be customized for your QTH. You can even produce timely predictions of sky wave conditions (or MUF) between any two points. Some programs can handle such chores as estimating LUF and other propagation parameters such as HPF and FOT, as well as signal strength, signal-to-noise ratio (S/NR), number and configuration of hops, long- and short-path distance and heading, radiation angle, time zones, and other parameters.

Pacific-Sierra Research's *HFx* is a popular *Windows* HF propagation prediction program. The HFx Hop Mode model generates field strength, mode, availability, and S/NR for a given date, transmitter and receiver pair, frequency, and antenna type. The program displays the data in several formats, including a graphic of sky wave ionospheric hops for each frequency at one-hour intervals, as shown in Fig. 3.

The HFx Global MUF model generates a color map of maximum usable frequency, frequency of optimum traffic, or highest possible frequency, as shown in Fig. 4. Using this model, you can determine the best frequencies to reach any part of the world. Global MUF geometry is depicted here on a rectangular projection.

SKYCOM 2.0, from Fuentez Systems Concepts, Inc., is an easy-to-use Windows program that presents a "quick-look" prediction for "yes-no-maybe" contact possibilities; you can also obtain a detailed report. Shown in Fig. 5 is the Advanced Parameters Window, where you can fine tune the program to better reflect prevailing conditions or set up "what if" scenarios.

MINIPROP PLUS 2.5 has significant graphical capabilities. Shown in Fig. 6 is a display of predicted MUF with a resolution of 30 minutes. The prompt line selections on the graph screen also allow you to view a graph of predicted signal levels or signal-to-noise ratio (S/NR) on each prediction frequency.

Summary. We have covered some of the more basic aspects of radio wave propagation: the electromagnetic spectrum; the nature of radio waves; the regions of the Earth's atmosphere; sunspots; propagation modes; the role of personal computers in forecasting; *etc.* This primer wasn't intended to make you a propagation pro, but with the information we've presented, you should be well on the way to understanding how propagation works and making the most of your newfound skills. ■

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ISCET invites all technicians to celebrate National Electronics Technicians Day during the Week of April 21 through April 25, 1998, which has been designated T-WEEK. If you are planning to take

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the CET exams, now is the time as during T-WEEK, ISCET's dedicated network of Certified Test Administrators will be providing opportunities for interested technicians to obtain their certification. Whether you are interested in completing your Associate or Journeyman Certificate, gaining continuing education units, or want to sit for one of many FCC elements, call one the examiners listed below for assistance. These test administrators are dedicated to the continued growth of the CET program and anxiously await your calls.

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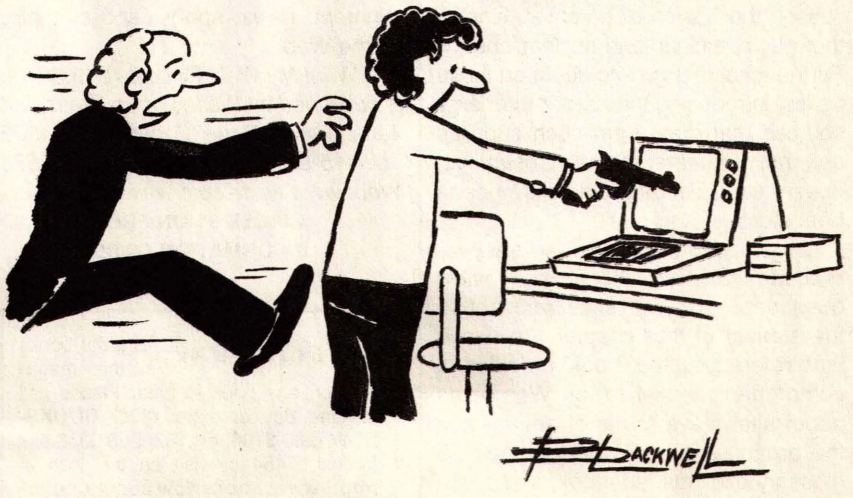

"No! No! No! That's not what I meant by trouble-shooting!"

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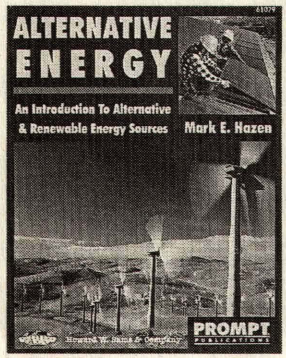
ALTERNATIVE ENERGY: AN INTRODUCTION TO ALTERNATIVE & RENEWABLE ENERGY SOURCES

by Mark E. Hazen

The world's energy needs are greater than ever before as populations increase and Asian countries awaken industrially and economically. As the demand for oil-based energy is increasing, the world supply is decreasing. Demand for fuel is outpacing the world's ability to produce it. Now more than ever, it is important to understand the energy problem and the alternatives that are available.



The author begins with a broad overview of electricity, explaining its various mechanisms from electro-mechanical and electromagnetic to thermo-, photo-, and piezo-electric. The second chapter defines energy and discusses the basics of potential, kinetic, thermal, chemical, and nuclear energy. Further chapters go into depth on these topics, introducing the reader to energy sources that draw from such supplies as wind, sun, water stored in reservoirs, ocean tides, ocean currents, ocean heat storage, and more.

Organized in a very clear, easy-to-read manner, each chapter has review questions and Web sites relevant to the subject of that chapter. An excellent reference, the book provides a comprehensive listing of Web sites about alternative forms of energy and the organizations devoted to them, a glossary of terms, an index, and a bibliography.

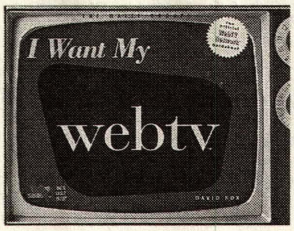
Alternate Energy costs $18.95 and is published by Prompt Publications, Howard W. Sams & Company, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2041; Tel. 800-428-7267 or 317-298-5400; Fax: 317-298-5604: Web: www.hwsams.com.

CIRCLE 90 ON FREE INFORMATION CARD

I WANT MY WEB TV

by David Fox

Designed for anyone who has a television and wants to hook up to the Web, this book is written in a witty and conversational style. An invaluable road map explaining what Web TV is and how to navigate it, it shows readers how to tune in, turn on, and hook up within minutes. The author also gives advice on surfing the Web, exploring cutting-edge places that Web TV can go.



Advanced features are covered, such as using e-mail, searching, creating favorites lists, blocking mature screens, and how to use credit cards safely on the Web. Guidance is provided on exploring travel, games, entertainment, news, sports, and shopping on the Web.

I Want My Web TV costs $19.99 and is published by Waite Group Press, 200 Tamal Plaza, Corte Madera, CA 94925; Tel. 415-924-2575; Fax: 415-924-2576; Web: www.waite.com/waite.

CIRCLE 91 ON FREE INFORMATION CARD

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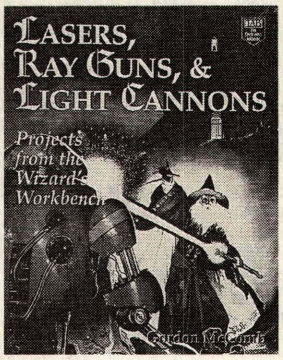
LASERS, RAY GUNS & LIGHT CANNONS: PROJECTS FROM THE WIZARD'S WORKBENCH

by Gordon McComb

In this 413-page book, there are over 88 laser and optics projects. Hobbyists, either expert- or student-level, are shown how to build the fun projects, using inexpensive, easy-to-obtain components. Projects include putting on a professional light show, creating holograms, performing dozens of experiments, and building a laser-ray gun. In other construction projects, the reader will learn how to detect intruders around a perimeter, measure precisely the speed of light, perform laser "snooping," transmit data with lasers, and carry voices over a beam of light.



Organized into 25 independent modules, the book presents the scientific history and theory, as well as both basic and advanced instructions for the projects themselves. In addition, there are chapters on tools for laser experimentation, buying laser parts, and computer-controlled laser projects.

Lasers, Ray Guns & Light Cannons: Projects from the Wizard's Workbench costs $21.95 and is published by McGraw-Hill, Inc., 11 West 19th St., New York, NY 10011; Tel. 800-2MCGRAW or 212-337-5951.

CIRCLE 92 ON FREE INFORMATION CARD

1997/98 ELECTRONIC INTERCONNECT GUIDE

from 3M Electronics Division

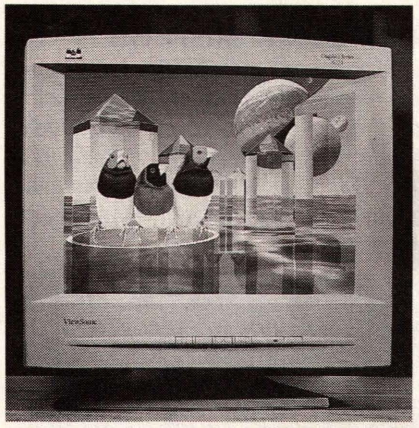
This 116-page catalog is a condensed

(Continued on page 42)

New Products

COMPUTER MONITOR

In keeping with concerns for environment issues, *ViewSonic Corporation's G773 17-inch Monitor* meets the safety, emissions and power management standards set by TCO '95 and NUTEK. Designed for SOHO and business graphics users, this monitor offers excellent screen performance and implements automatic power-savings mode during periods of inactivity.



With its super-fine 0.26mm dot pitch and Invar shadow mask, the View Sonic G773 produces clear, sharp images. This clarity is enhanced by advanced SuperClear screen technology that combines exceptional focus found in high-contrast conventional CRTs with the bright, vivid colors associated with aperture grille CRT monitors, creating crisp, color-rich images. A special screen treatment reduces annoying glare and reflection.

Featuring a horizontal scan rate of 30–70 kHz, a vertical scan rate of 50–160 Hz, and a refresh rate of 87Hz at a resolution of 1024 × 768, this monitor operates in both PC and Mac environments. The G773 offers easy-to-use controls, a user-friendly on-screen menu for all screen adjustments, and Plug&Play+, which supports Windows 95 requirements, for easy configuration and set up.

The estimated street price is $510. For more information, contact ViewSonic Corporation, 20480 Business Parkway, Walnut, CA 91789; Tel. 800-888-8583 or 909-869-7976; Fax: 909-468-3756; Web: *www.viewsonic.com.*

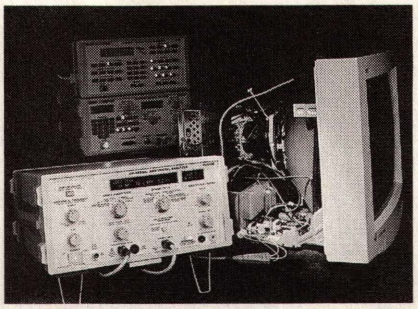
CIRCLE 80 ON FREE INFORMATION CARD

UNIVERSAL HORIZONTAL ANALYZER

This product-test equipment works with all computer monitors, televisions, projection TVs, and other CRT video displays—all in one instrument. Providing everything you need to localize horizontal and B+ supply defects in computer monitors, the *HA2500 Universal Horizontal Analyzer* does it in less time and more efficiently than ever before.

The HA2500 offers a unique frequency lock and variable horizontal frequency system that allows quick servicing of all horizontal circuits no matter the frequency (15 kHz to 125 kHz). It also provides a "Horizontal Output Load Test" that makes set up and testing a snap, allowing a circuit to be tested without even applying AC power. This guarantees accurate estimates, reduces the number of damaged replacement parts, and speeds the technician's diagnosis and repair.

In addition, the unit incorporates a patented "Ring" test for analyzing IHVTs, flybacks, and yokes in seconds. The "Dynamic Tests" feature analyzes horizontal circuits in a powered-up condition to catch even subtle defects in the power supply and drive signal. This test can eliminate call-backs and reworks associated with horizontal circuits. A special variable-current limited and protected B+ substitute supply is bundled with the HA2500, and this allows the technician to test and troubleshoot even when the power supply of the unit being tested is dead.

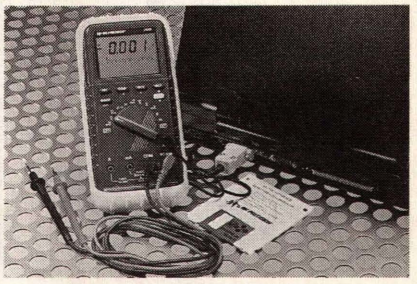


The HA2500 Universal Horizontal Analyzer costs $2895. Contact Sencore, Inc., 3200 Sencore Drive, Sioux Falls, SD 57107; Tel. 800-SENCORE or 605-339-0100; Fax: 605-339-0317.

CIRCLE 81 ON FREE INFORMATION CARD

AN INTERFACE MULTIMETER

Permitting data logging directly to a personal computer via a built-in RS-232 interface port, the handheld *Model 2880* digital multimeter is an all-in-one instrument. The 2880 DMM measures true RMS values and is a cost-effective device.



The triple LCD display with 4000 count resolution and a fast update analog bargraph that are incorporated makes measurements easy to read. Min, Max, and Present readings can be displayed simultaneously, or the mode can be changed to display Min, Max, and Average readings simultaneously instead. The triple display function can also be used in the Compare Mode, where high and low limits may be set and displayed, while the main display indicates PASS or FAIL when measurements are compared to the preset limits. In the Dual Display Mode, the LCD can also simultaneously display AC voltage and Frequency (200 Hz–200 kHz with 20,000 count display).

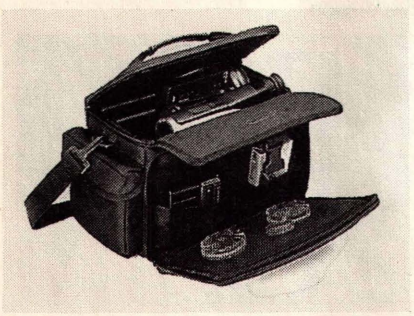
Measurement functions include AC/DC volts, AC/DC current, resistance (auto/manual ranging), continuity and diode test, capacitance (400 nF–40 μF) 10-megohm input impedance, and overload protection at 1000-volt peak (600-volt peak on 40-mV range.) Priced at $189, the Model 2880 DMM comes with software diskette, as well as the RS-232 interface cable.

All B&K Precision products are available worldwide through a global network of authorized distributors. For more information, contact B+K Precision, 4353 W. Lawrence Avenue, Chicago, IL 60630; Tel. 773-725-9252; Fax: 773-725-9385; Web: *www.bkprecision.com.*

CIRCLE 82 ON FREE INFORMATION CARD

CAMERA/CAMCORDER BAGS

Designed specifically for customers seeking specialty equipment storage and portability, these five nylon camera/camcorder bags are loaded with pockets that carry 35mm SLR cameras or compact camcorders, and all the accessories the photographer needs. The *CBV-1* and *CBV-2* Camera/Video bags are padded for extra protection, feature a shoulder strap, compartments for film, and adjustable dividers.



The *CBV-10, -11, and -12* are targeted for camcorder users. Features include thick padding, a panel for business cards, inner panel pockets, nylon mesh pockets on both ends for batteries and film, and a protective armored and waterproofed bottom. In addition, the CBV-11 has a detachable case so when all the extra accessories aren't needed, the camcorder carrier can be used alone. The CBV-12 offers extra protection with pull-over security flaps and safety buckles.

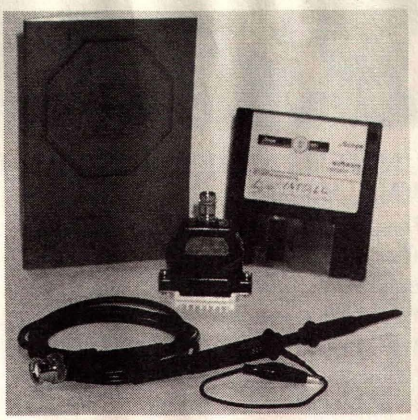
Prices range from $19.99 for the CBV-1 to $49.99 for the CBV-12. Contact Case Logic, 6303 Dry Creek Parkway, Longmont, CO 80503; Tel. 800-925-8111 or 303-530-3800; Fax: 303-530-3822; Web: *www.caselogic.com* for more information.

CIRCLE 83 ON FREE INFORMATION CARD

SCOPE ON A DISK

The *uScope* is one of a series of eight multifunctional computer-controlled measuring instruments available from *T P Engineering*. It is a single-channel unit with eight-bits resolution that plugs into the printer port of a desktop, laptop, or notebook computer. Measurements are derived by sampling the input signal; digitizing the values; and processing, saving, and displaying them.

Performing effective sampling at 100,000 samples per second, the uScope can be used as an oscilloscope, storage oscilloscope, spectrum analyzer, true RMS voltmeter, or transient recorder—with the accompanying software. Other values, such as temperature, pressure, and frequency, can be measured as well, since the software allows the instrument to be reconfigured to do so.



The program can be controlled by mouse or by cursor keys. Collected data can be directly recorded onto disk or printed out. There is an option to write additional software in C, Pascal, or Basic.

The uScope with disk and manual costs $170. For more information, contact T P Engineering, 239 Park Avenue, Berkeley Heights, NJ 07922; Tel. 908-464-5486.

CIRCLE 84 ON FREE INFORMATION CARD

ACCESSORY KITS

ITT Pomona recently introduced an assortment of *Test Companion Kits* specially designed for the most popular Fluke, Hewlett-Packard, Tektronix, and Wavetek benchtop DMMs. The durable, lightweight accessory pouch mounts easily on top of the instrument. Multiple zippered compartments for convenient accessory storage are included.

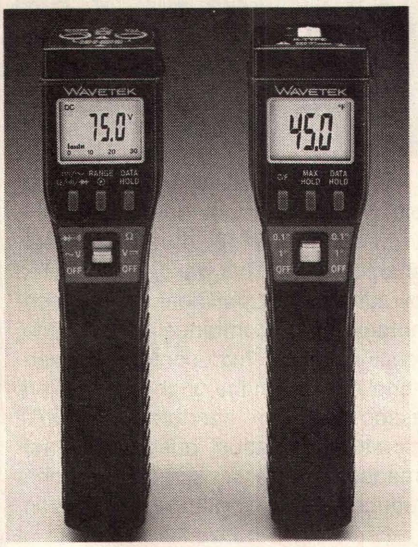
The 6176 Test Companion Kit is specifically designed for use with Fluke 45, 8840, 8842, and PM2525 benchtop multimeters. The kit includes a safety sheath style flexible test lead set, test probe handle set with banana plug tip, medium alligator clip set, Maxigrabber with pincer tip, and insulated spade lug set. The 6177 Test Companion Kit, which is compatible with the same Fluke multimeters, includes a wider selection of lab and benchtop accessories.

The Test Companion Kits range in price from $88 to $112. Contact ITT Pomona Electronics, 1500 E. Ninth Street, Pomona, CA 91766-3835; Tel. 909-469-2900; Fax: 909-629-3317; Web: *www.ittpomona.com*.

CIRCLE 85 ON FREE INFORMATION CARD

MINI-STICK METERS

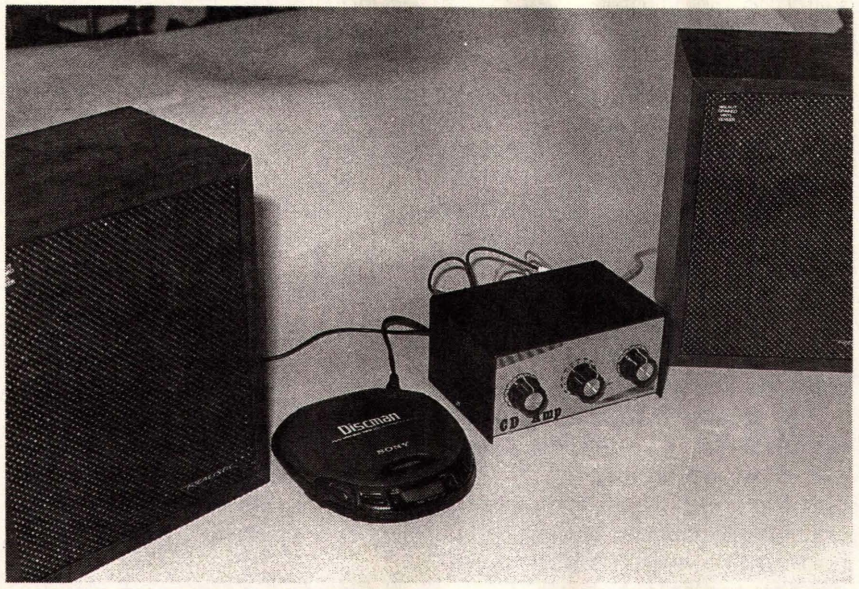
Traditional handheld DMMs have to be laid aside while the technician is holding the test leads. *Wavetek's* uniquely shaped digital multimeters, the *ST75* and *TM45*, allow the user to simultaneously hold the meter safely and read the display.



A complete volt/ohm stick DMM, the ST75 features digital and analog bargraph display, 3200-count resolution, autoranging, data hold, quick continuity checking, and diode testing. It measures DC and AC voltage up to 600 volts and resistance up to 32 megohms. Geared to commercial and industrial applications, the TM45 is a digital thermometer with a wide temperature range up to 2000° Fahrenheit and 1300° Celsius and is capable of data and maximum display hold. Temperature measurement is switchable between Fahrenheit and Celsius, and the device is compatible with Type K-thermocouples.

(Continued on page 54)

BUILD THIS
PORTABLE CD AMP



With nothing more than a pair of low-wattage speakers and this little amplifier, you can use your portable CD player to fill your patio, backyard, or any room in your home with your favorite music.

HOMER L. DAVIDSON

Like the Walkman, personal CD players have become an intricate part of the exercise regimen of the health conscious. But once you've finished that two mile jaunt, it would be nice to just sit back and, while unleashed from your CD player, listen to some good music. Of course, portable CD players can be connected to your full-size audio-component system. But that often requires climbing over furniture or moving furniture around in order to get at the line inputs at the rear of your audio system. And what if you want to sit out on the patio or in your backyard while you relax to some soothing sounds—do you lug your full-size speakers, connected to your in-house stereo system through about a "mile and a half" of speaker cable, out back so that you can lounge in your hammock while the music takes you away?

With the *Portable CD Amp* described in this article, you needn't deal with any of the difficulties that might be encountered when trying to connect a portable CD to a stationary audio system. The stereo outputs of the Portable CD Amp pumps out plenty of volume for its size—four watts of crisp clean audio that can be used to drive a pair of small 8-ohm speakers—and features a dual-tone control. Best of all, this small amplifier, which can be built for less than 20 bucks, allows you to enjoy your portable CD player unencumbered by its "mooring lines."

Circuit Description. A schematic diagram of the Portable CD Amp is shown in Fig. 1. At the heart of the circuit is an LM2877 dual four-watt audio power amplifier (IC1), which is designed to deliver 4 watts of continuous power per channel into an 8-ohm load. Each of the amplifiers within that single-inline monolithic chip—which can be operated from a 12- to 20-volt power source and requires few external components—is biased from a common internal regulator to provide high power-supply rejection.

The stereo output of the portable CD player is applied to the Portable CD Amp through a stereo patch cord that connects to J1 and J2 (the left and right channel inputs to the stereo amplifier). The volume for the two channels is controlled via a pair of 100k potentiometers (R1 for the left channel and R10 for the right channel). From the volume controls, the left- and right-channel signals are coupled through a pair of capacitors (C1 and C6) to pins 4 and 8 of IC1. Those capacitors allow the audio signals to pass, while blocking any DC component that may be present in the audio input. Note that the input to IC1-a is applied to its inverting-input terminal at pin 4, while the input to IC1-b is applied to its non-inverting terminal at pin 8.

The other inputs to the two amplifiers (at pin 5 and pin 7) are connected to a dual tone-control circuit—one built around R3-a (the left channel) and the other built around R3-b (the right channel). Since the two channels are nearly identical (except that one channel uses the non-inverting input to the amplifier, while the other uses the amplifier's inverting input), from here we'll refer only to the left channel of the circuit. However, anything said about the left channel also applies to the right channel.

The output of the amplifier (IC1-a) divides along two paths. In one path, the amplified output of IC1 is fed back to the left channel tone-control network, which is comprised of R2, R3-a, R4–R6, and C2–C4. The circuit, which is essentially a variable passive RC filter, is used to select the

frequency of the feedback signal. The selected feedback frequency is applied to the non-inverting input of IC1-a at pin 5. That decreases that frequency's presence in the output signal. (In the right channel, the feedback signal is applied to the inverting input at pin 7, and the direct signal is applied to the non-inverting input at pin 8 and produces a similar effect in that channel.) In the other path, the frequency-adjusted output of the amplifier at pin 2 is fed through a 470-µF capacitor (C12) to the output jack (J3), and is used to drive an 8-ohm speaker.

The Portable CD Amp can be powered from an appropriate 12-volt battery source or from a DC power supply like that shown in Fig. 2, which is comprised of a 12-volt, step-down transformer (T1), a full-wave bridge rectifier (consisting of four 1N4002 1-amp, 100-PIV rectifier diodes, D1–D4), and a 6800-µF filter capacitor (C16). The circuit in Fig. 2 provides an output of 18.6 volts to operate the Portable CD Amp (draws under 100 mA at mid-volume). You can build a similar power supply or operate the circuit from a plug-in DC power pack. When S1 is closed, power is fed through the switch to pin 11 of IC1, energizing the circuit.

Construction. The Portable CD Amp was assembled on a printed circuit board, measuring 3 by $5^{1}/_{16}$ inches. A template of the author's printed-circuit layout is shown in Fig. 3. That layout can be copied from the page and used to etch your own printed-circuit board. Once you've etched your board and obtained all of the components listed in the Parts List, construction can begin.

The parts-placement diagram for the author's printed-circuit layout is shown in Fig. 4. Start by installing the passive components, and then connect lengths of hookup wire where off-board components are indicated.

Carefully mount and solder IC1 to the circuit board in the location indicated in the parts-placement diagram. IC1 is soldered directly to the printed-circuit board. All of the components, with the possible exception of the LM2877, can be found at your local electronic sup-

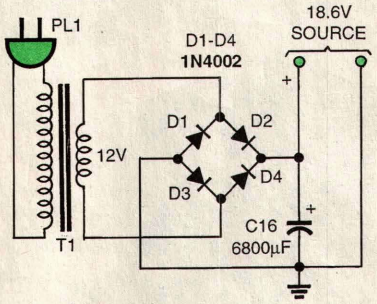


Fig. 2. The author's version of the Portable CD Amp was powered from a 12-volt DC power supply comprised of T1 (a 12 volt, step-down transformer), D1–D4 (four 1N4002 1-amp, 100-PIV rectifier diodes, which form a full-wave bridge rectifier), and C16 (a 6800-µF, filter capacitor).

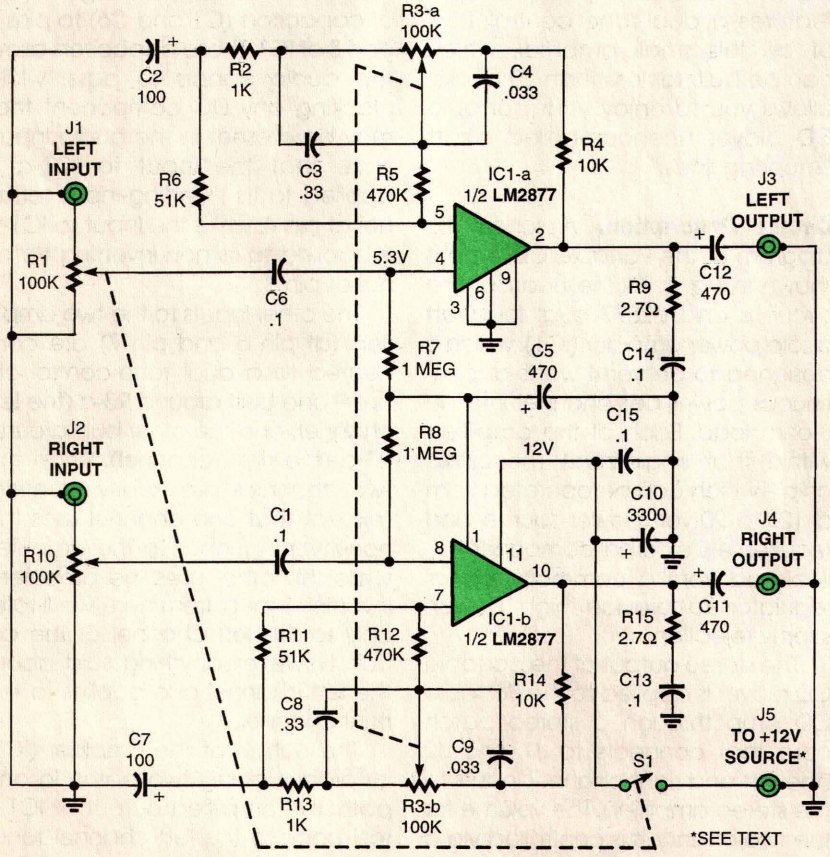


Fig. 1. At the heart of the Portable CD Amp is an LM2877 dual four-watt audio-power amplifier (IC1), a single-inline monolithic chip that requires few external components and can be operated from supply voltages ranging from 12- to 20-volts.

PART LISTS FOR THE PORTABLE CD AMP

RESISTORS

(All fixed resistors are $^{1}/_{2}$-watt, 5% units.)
R1, R10—100,000-ohm, audio-taper potentiometer (see text)
R2, R13—1000-ohm
R3—100,000-ohm dual-gang potentiometer (see text)
R4, R14—10,000-ohm
R5, R12—470,000-ohm
R6, R11—51,000-ohm
R7, R8—1-megohm
R9, R15—2.7-ohm

CAPACITORS

C1, C6, C13, C14, C15—0.1-µF, ceramic-disc
C2, C7—100-µF, 35-WVDC, electrolytic
C3, C8—0.33-µF, ceramic-disc
C4, C9—0.033-µF, ceramic-disc
C5—47-µF, 35-WVDC, electrolytic
C10—3300-µF, 35-WVDC, electrolytic
C11, C12—470-µF, 35-WVDC, electrolytic
C16—6800-µF, 50-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIAL

IC1—LM2877 dual 4-watt, audio-power amplifier, integrated circuit
J1–J4—Shielded RCA jack
J5—Insulated power jack
S1—SPST switch (part of R1, see text)
Printed-circuit material, pair of 4 × 6-inch (or larger) 8-ohm speakers, $3^{1}/_{16}$- × $6^{1}/_{4}$- × $4^{1}/_{8}$-inch metal enclosure, heatsink, wire, solder, hardware, *etc.*

ply house. If your local supplier does not carry the LM2877, it can be obtained by mail-order from either Digi-Key Corporation (701 Brooks Avenue South, Thief River Falls, MN 56701-0677, Tel. 800-344-4539) or Jameco Electronic Components (1355 Shoreway Road, Belmont, CA 94002-4100, Tel. 800-831-4242). After soldering IC1 to the printed-circuit board, check between each terminal with an ohmmeter for shorted connections. You should have no measurement below 1k between any two terminals. If you find two terminals that are soldered together, remove the excess solder with the soldering iron and solder wick. Once that is done, connect the tab of the IC to a large heatsink with a couple of screws and secure the heatsink to the board with appropriate hardware.

Next wire the off-board components to the circuit through appropriate lengths of hookup wire. Note that while R1, R3, and R10 have the same value, they are not interchangeable; R3 is a dual-gang 100k unit, R10 is a plain ol' vanilla component, and R1 has switch S1 piggybacked to it. Of course, the R1/S1 combination could be replaced by separate units if desired. The choice is yours. In any event, connect a pair of RCA jacks (for J1 and J2) to one end of both R1 and R10, and ground the other ends of the potentiometers as well as the free terminals of the jacks. Then connect the wipers of the two potentiometers to the appropriate points on the circuit board. Connect another pair of RCA jacks to the circuit where J3 and J4 are indicated. Connect the final jack (J5) to S1.

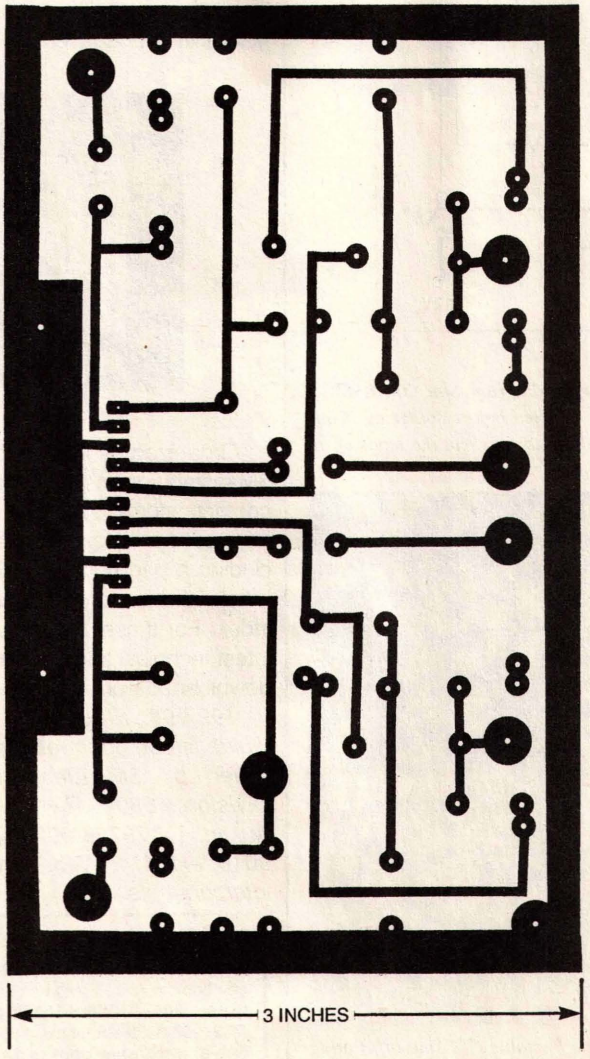


Fig. 3. The Portable CD Amp was assembled on a printed-circuit board, measuring 3 by $5^{1}/_{16}$ inches. A template of the author's printed-circuit layout is shown here full-size.

Testing. Double check all wiring before testing the amplifier. Apply a +12-volt source to J5. Connect a pair of 8-ohm speakers to the left- and right-channel outputs, J3 and J4. Always have both speakers connected before powering up the Portable CD Amp as the CM2877 may be damaged if the volume is turned up and the speakers are missing. Set the volume controls to about midrange, and flip S1 to the on position. You should hear a very low hum in each speaker. Lightly touch one of the shielded input jacks (J1 or J2). Touching the jack should cause the volume of the hum in that channel to increase. Test the second channel input in the same manner.

If the circuit does not respond as expected—*i.e.*, no hum is heard at either speaker—check the voltage at the positive terminals of C10 and C15; you should get a reading of 12 volts at both points. Suspect a leaky IC or improper IC connections if the voltage at pin 11 is low. If you get a proper reading, check the voltage at each terminal of IC1. The voltage at pins 5 and 7 should be 5.9 volts; pins 4 and 8 should be at 5.3 volts; and pins 2 and 10 should be at 5.97 volts. If those points check out, turn off the power and measure the circuit's resistance from the power supply input (J5) to ground; you should get a reading of over 5k. Check the printed-circuit wiring for poor solder connections. When one channel is dead or has minimum volume, suspect a defective IC, connecting part, or improper connection. The voltage and resistance should be the same for each channel.

Once the circuit is functioning properly, prepare the enclosure that will house the circuit board. The author's unit was housed in a $3^{1}/_{16}$- × $6^{1}/_{4}$- × $4^{1}/_{8}$-inch metal cabinet. Three appropriate sized holes were drilled in the front panel of the enclosure to accommodate the three potentiometers, R1, R3, and R10. Five holes were drilled in the rear panel to accommodate the jacks: four for the left and right channel input and output jacks, and one for the power jack. Additional holes were drilled in

the floor of the enclosure for mounting hardware for the printed-circuit board. The board was mounted on 1/4-inch spacers to the bottom of the cabinet.

The front and rear panels of the Portable CD Amp's enclosure can be labeled using dry-transfer lettering. Labeling the rear panel jacks will help to prevent the amplifier from being hooked up improperly. Labeling the front and rear panels of the unit helps to enhance its appearance.

Once the circuit has been tested and mounted in its enclosure and you have made any cosmetic adjustment that you care to make to the enclosure, the Portable CD Amp is ready to pump out your favorite tunes in any location that you choose. ■

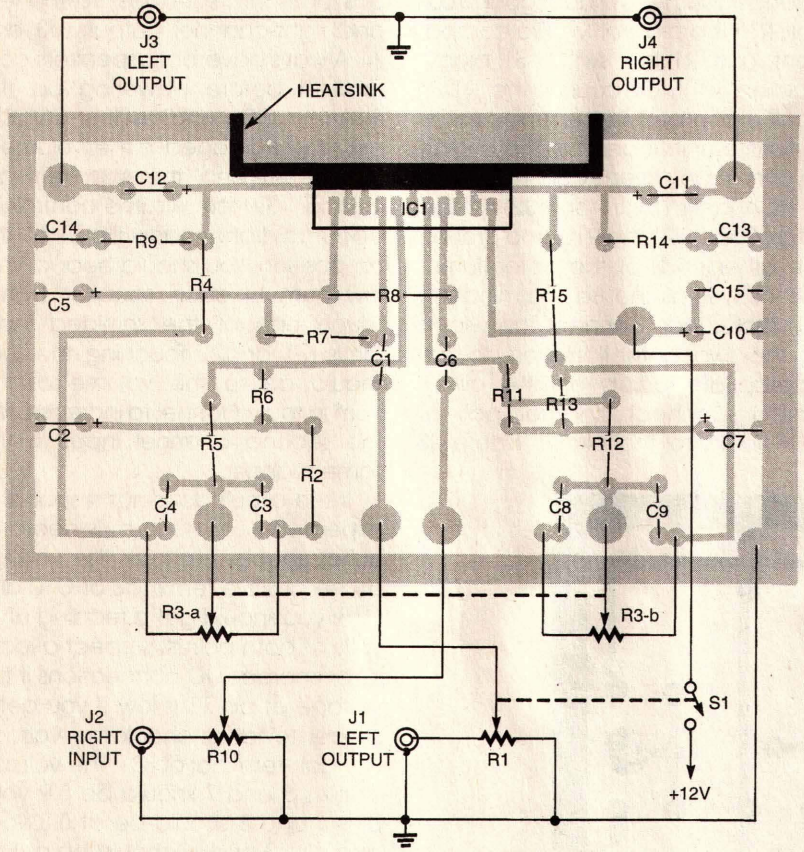
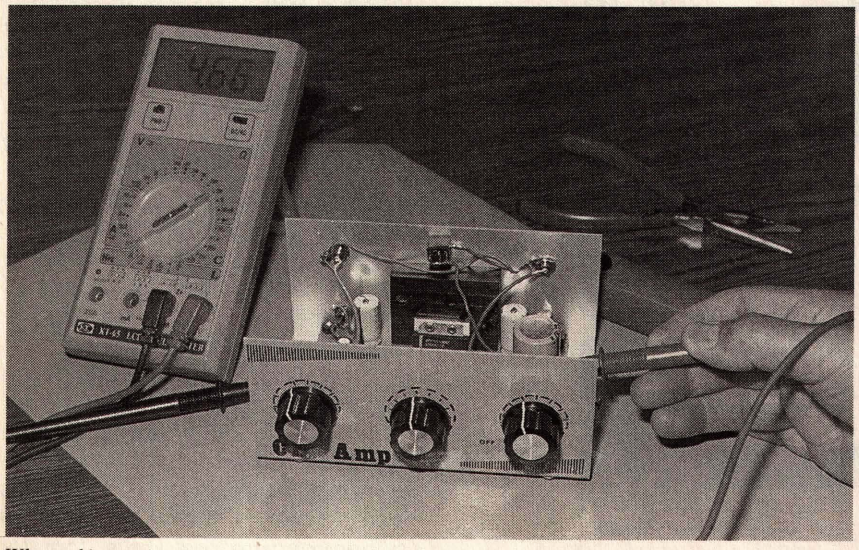


Fig. 4. Assemble the Portable CD Amp guided by this parts-placement diagram. Since the LM2877 is mounted directly to the board, be careful the chip is properly oriented before soldering it into place; when soldering the IC to the circuit board, be extra careful not to overheat the leads of the component, as overheating the leads can cause damage to the chip.

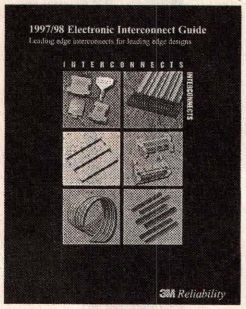


When taking resistance measurements, be sure to turn power to the Portable CD Amp off; failing to do so will damage the resistance measuring circuitry of the meter. When taking voltage measurements be sure that the meter is set to the DC scale and on a range that is higher than the anticipated voltage in the circuit.

ELECTRONICS LIBRARY

(continued from page 36)

version of the full 3M catalog. It has information on interconnect system connectors; assembly equipment; cable; fiber-optic products; heat-shrink products; tape, terminals, and tools; wire connectors; and wire identification products. It includes product descriptions and photos, as well as complete ordering information. The catalog is three-hole drilled for convenient storage.



Organized by application, it includes 3M distributor and international location contact information. The catalog contains several indexes for ease of use, including a part number index, a general index, and a technical service drawing index. For those who require them, the latest technical service drawings can be downloaded from the 3M Web site.

1997/98 Electronic Interconnect Guide is free upon request and is published by 3M Electronic Products Division, 6801 River Place Blvd., Austin, TX 78726-9000; Tel. 800-328-0016, ext. 114; Web: www.mmm.com/interconnects. ■

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Microcontrollers II

JEFF HOLTZMAN

My original concept for this series on microcontrollers was to cover the extremely popular PIC series. However, I am unquestionably late to the party. There is lots of good information to be had on the PIC, including the books (discussed last month) published by Square One Electronics, and tons of sources all over the Internet.

Instead, I have decided to change gears and talk about a different chip family: Atmel's AVR series, in particular, the *AT90S1200*. I didn't pick that device at random. The chip itself has an amazing set of capabilities, it is (relatively) new, and it hasn't been fully dissected like the PIC family. This month I'll give an overview of the 1200. Next time—I promise—we will start getting our hands dirty.

OVERVIEW

The AT90S1200 is a 20-pin device available in 0.3-inch Dual-In-Line Package (PDIP) form, in Shrink Small Outline Package (SSOP), and in Small Outline Integrated Circuit (SOIC) packages. It is fully CMOS—the clock may range from 0–16 MHz, and power source ranges from 2.7–6.0 VDC.

Other features include a built-in 1-MHz (approximate) RC oscillator (so the chip can literally run stand-alone, with no external components), and optional operation with a crystal or ceramic resonator. In addition, the 1200 includes: 15 latched general-purpose I/O lines (each with 20 mA of current-sinking capability, or 140 mA total), 1K bytes of flash, 64 bytes of EEPROM, internal and external interrupts, a watch-dog timer, an 8-bit counter/timer (with prescaling), two low-power modes, and an analog comparator.

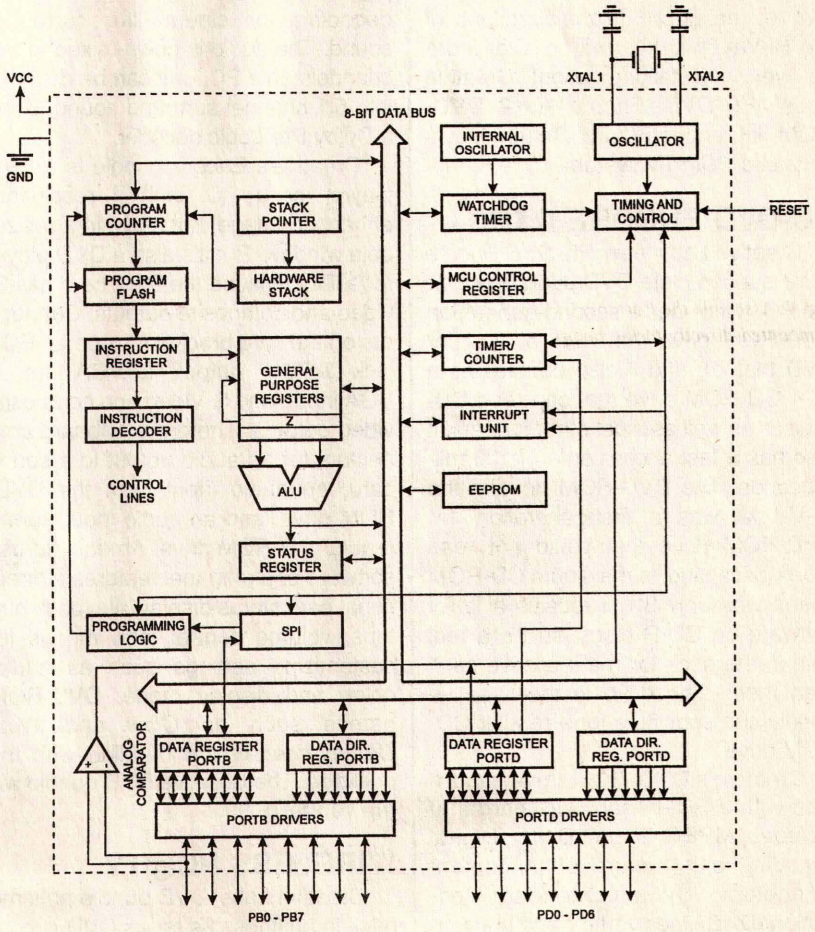
Architecturally, the 1200 contains 32 8-bit registers, an 8-bit data bus, and a three-level hardware stack (I hate that). It has four separate memory spaces: flash (where programs run); EEPROM (data storage); and an I/O space for accessing interrupt control registers, port control registers, timer/counter, watch-dog timer, comparator functions, and so on. The fourth memory space contains three registers with device-code information, such as manufacturer, device type, and flash size. The program space (flash) is 16 bits wide, so the 1K of flash is somewhat misleading. It actually provides 512 words of program code. The program counter is 9-bits wide, as is the stack.

The 1200 can be programmed in two ways—via serial (SPI) and parallel interfaces. Serial mode is designed for in-circuit updates; only normal V_{CC} is required. Parallel mode requires a +12-VDC source (used as an enable signal and not to power anything heavy-duty), provides faster operation, and allows access to the 1200's "fuse bits," which cannot be changed otherwise.

The fuse bits (RCEN and SPIEN) control two aspects of operation. RCEN enables the on-board RC oscillator. SPIEN enables serial programming mode. By default, RCEN is erased, disabling the oscillator, and SPIEN is programmed, enabling serial programming. The 'A' version of the 1200 comes with RCEN programmed.

A separate set of bits provides three program locking modes: unlocked (default), locked, and locked plus verify disabled. When locked, flash cannot be programmed. The program memory

(Continued on page 46)



The Atmel/MVS 1200 microcontroller block diagram. This microcontroller can run with no (!) external components, provides 15 bits of I/O, has 512 words of flash program memory, 64 bytes of EEPROM, an analog compactor, and supports in-circuit programming. With care, you can program it directly via the serial or parallel port of a PC.

Multimedia Watch

A DVD-ROM Kit, a Wireless PC, and New Software

MARC SPIWAK
ASSOCIATE TECHNICAL EDITOR
COMPUTER RESELLER NEWS

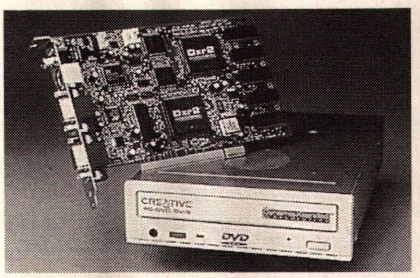
As I've mentioned before, one of the best things about writing this column is getting all of the new equipment to test. But the downside is that I usually have to return the hardware. Such was the case with my *Hi-Val DVD* upgrade kit that I had to return recently. That single package let me play DVD movies on my PC, transmit them to my home entertainment system and watch them on a big-screen TV.

Fortunately for me, I'm always getting new gadgets, and the new stuff is usually better than what it replaces. I recently received two new products that let me duplicate the functions of the Hi-Val DVD kit, and do a lot more as well. I'm talking about Creative Labs' *PC-DVD Encore Dxr2* DVD-ROM kit and RF Link Technology's *Wireless PC@TV* system.

PC-DVD ENCORE DXR2

Creative Labs' new *PC-DVD Encore Dxr2* is a complete DVD upgrade kit for the PC. It includes a second-generation DVD-ROM drive that runs at 2× (for DVD that is), and it also doubles as a 20× CD-ROM drive that can read CD-R discs as well as most other formats. It also has a fast access time of 100 milliseconds. The DVD-ROM drive in the Hi-Val kit was a first-generation 1× DVD-ROM drive that could not read CD-R discs, and its maximum CD-ROM speed was only 8×. I receive a lot of software on CD-R discs, so it's a real pain in the neck for me if a drive can't read them. The drive in the Creative bundle can substitute for a regular CD-ROM drive.

Creative's DVD-ROM drive is bundled with a PCI-based Dxr2 card that includes MPEG-2 and Dolby Digital decoding plus picture enhancement technology. DynamicXtended Resolution (Dxr2) uses vertical and horizontal interpolation filters and double-scanning up to 60 fields/second to eliminate artifacts at Windows resolutions up to 1280 × 1024. The Dxr2 card also



Creative Labs' PC-DVD Encore Dxr2 includes a second-generation DVD-ROM drive that runs at 2× (for DVD) and doubles as a 20× CD-ROM drive that can read CD-R discs.

provides Dolby Digital AC-3 audio decoding for cinema-like surround-sound. The audio is down-mixed to two channels on a PC, or it can be decoded into 5.1-channel surround sound, using a Dolby Pro Logic decoder.

Creative's Encore bundle is a DVD player for a PC, with a resolution-enhanced image that plays in a resizeable window. But it's also a DVD player for a TV, because the Dxr2 card has S-video and composite outputs. Connectors on the card bracket include an RCA jack S/PDIF output, a VGA output, VGA input, and S-Video and composite video outputs. There are onboard connectors for an audio output to a sound card, an audio input from the DVD-ROM drive, and an audio input from a regular CD-ROM drive. An easy-to-use software control panel features a directional pad, status display, playback buttons, volume control, and menus for customizing settings such as audio, color, and display mode. DVD-ROM games such as *Claw* and *Wing Commander IV* are bundled with the package. The Creative DVD bundle will run you $379.99.

WIRELESS PC@TV

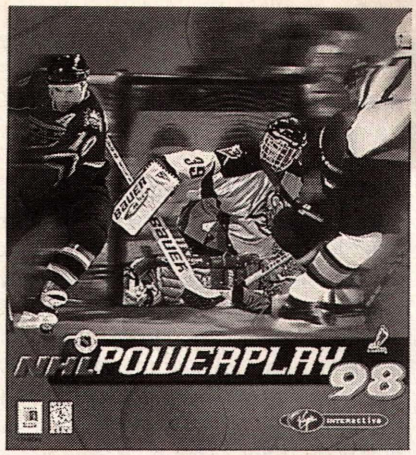
Creative Labs' DVD bundle puts me back in business as far as DVD is concerned, but it can't transmit video to my TV, and it comes with a relatively short video output cable for connecting to a TV. Enter RF Link Technology and its *Wireless PC@TV*. This package includes the same Wavecom Sr. wireless audio/video transmitter that came with the Hi-Val DVD kit, so I can again broadcast DVD video—or any video—to my TV set. But the *Wireless PC@TV* bundle also lets me enjoy the Internet, computer games, and more, all on my TV set.

The *Wireless PC@TV* bundle includes the wireless audio/video transmitter and a wireless keyboard/mouse. Wavecom Sr. transmits a computer's video and audio through walls to a television in another room. One of the Wavecom Sr.'s more advanced features is that it can also relay infrared remote control signals to a device in another room. PC@TV takes advantage of that feature by sending commands from a wireless keyboard to the PC. So the user can sit in the living room watching the video output from the PC on a big-screen TV while controlling the PC with the wireless keyboard and its built-in mouse. Special software by Vidam Communications, Inc. conditions web pages and text for clear viewing on a TV set.

Aside from being couch-potato friendly, *Wireless PC@TV* is also very useful for delivering business presentations. It has a transmission range of up to 100 feet through walls, floors, and ceilings, and the PC@TV bundle includes all necessary hardware, software, and accessories. It's a very useful bundle for $599.99.

SLIMSCSI

Notebook computers are quite powerful these days, and it would be nice if you could use fast desktop SCSI peripherals with them. Of course you can, with Adaptec's *SlimSCSI 1480* PC Card SCSI adapter. It connects to any SCSI device and delivers PCI desktop performance to the portable PC with data transfer rates up to 20 MB/second with UltraSCSI devices, and up to 10 MB/second with Fast SCSI devices. Up



NHL Powerplay '98 features the actual styles and abilities of every player in the NHL. Accurate skating physics create realistic action.

to three SCSI devices can be daisy-chained. The Type II PC Card will work in any notebook computer with a CardBus-enabled PC Card slot. It's not every day that I need to use *SlimSCSI*, but if I ever need to connect a tape backup, CD-R drive, or other SCSI peripheral to my notebook computer, *SlimSCSI* will let me do it. The manufacturer's suggested retail price (MSRP) is $239.

NEW SOFTWARE

Symantec's *Norton Uninstall Deluxe* is a safe way to make changes on any Windows 95 or Windows NT 4.0 system, including both removing and adding programs and files. InstallGuard lets you remove the last installation and return a system to its original state. SafetyScan ensures accurate knowledge of your system and configuration for a safe and complete Remove, Move, Copy and Store of all applications and files—even ones that were on the system before Norton Uninstall Deluxe. Autoclean automatically frees up space on a hard disk by removing unnecessary files each time the system boots. This program will remove $39.95 (MSRP) from your wallet.

If you've had your share of computer problems, *CheckIt* (version 5) for Windows 95 from TouchStone Software provides tools to help pinpoint and solve those problems, backup and restore system files, install new hardware, uncover conflicts, and optimize system performance. *CheckIt* offers comprehensive information displays identifying everything users need to know about their motherboard, memory, modem, drives, video, ports, printer, and Internet connections. *CheckIt* monitors all system resources, highlights conflicts, and guides the user through the repair. CheckIt automatically saves Windows Registry and critical system files so users always have a recent backup. *CheckIt version 5* is $49.95.

If you like to play Monopoly but would rather watch Star Wars, then maybe *Star Wars Monopoly* can pry you away from the big screen. This neat game from Hasbro Interactive has you playing a multimedia version of the famous real-estate trading game. But instead of trading depression-era real estate on earth, you are in a galaxy far, far away, vying for your favorite Star Wars real estate on a quest to conquer the galaxy. C-3PO is there in his ever-polite form as an intergalactic banker. Galaxy trading starts at $49.99.

Sabre Ace: Conflict Over Korea from Virgin Interactive gives you a chance to be a fighter pilot during the Korean War. Battle in an F-86 Sabre jet or choose from four other planes: the F-51 Mustang, the F-80 Shooting Star, the MiG-15, or the YAK-9. You fly as a U.S. fighter pilot in the Mustang, Shooting Star, and Sabre, or in the Soviet military aboard the YAK-9 and MiG-15. You can even engage in dogfights with friends via modem, serial, or LAN connections. Design your own dogfights or jump right into combat—it's all up to you. For an estimated street price (ESP) of $44.99, you too can enter the dogfights.

NHL Powerplay '98, also from Virgin, is just what hockey fans have been waiting for. This sequel to *NHL Powerplay '96* is better than ever. Different players have their own particular styles in the game, and the action is modeled after the real players' styles. The actual styles and abilities of every player in the NHL delivers the most realistic PC hockey

WHERE TO GET IT

Activision
11601 Wilshire Blvd., Suite 1000
Los Angeles, CA 90025
310-255-2000
www.activision.com
CIRCLE 60 ON FREE INFORMATION CARD

Adaptec, Incorporated
691 South Milpitas Boulevard
Milpitas, CA 95035
408-945-8600
www.adaptec.com
CIRCLE 61 ON FREE INFORMATION CARD

Creative Labs
1901 McCarthy Blvd.
Milpitas, CA 95035
800-998-5227, 408-428-6600
www.creativelabs.com
CIRCLE 62 ON FREE INFORMATION CARD

Hasbro Interactive
50 Dunham Road
Beverly, MA 01915
508-921-3700
www.hasbro.com
CIRCLE 63 ON FREE INFORMATION CARD

LucasArts Entertainment Company
PO Box 10307
San Rafael, CA 94912
415-472-3400
www.lucasarts.com
CIRCLE 64 ON FREE INFORMATION CARD

RF Link Technology, Inc.
411 Amapola Ave.
Torrance, CA 90501
310-787-2328
www.rflinktech.com
CIRCLE 65 ON FREE INFORMATION CARD

Symantec Corporation
10201 Torre Avenue
Cupertino, CA 95014
800-441-7234
www.symantec.com
CIRCLE 66 ON FREE INFORMATION CARD

TouchStone Software
2124 Main Street
Huntington Beach, CA, 92648
800-932-5566, 714-969-7746
www.touchstonesoftware.com.
CIRCLE 67 ON FREE INFORMATION CARD

Virgin Interactive Entertainment
18061 Fitch Avenue
Irvine, CA 92714
714-833-8710
www.vie.com
CIRCLE 68 ON FREE INFORMATION CARD

VtechSoft
5 Corporate Park Drive, Suite 210
Irvine, CA 92606
800-742-1050
www.vtechsoft.com
CIRCLE 69 ON FREE INFORMATION CARD

game ever created. Accurate skating physics create realistic action, and there are five playable camera angles to select from. A multiplayer mode lets you play with up to five friends. The ESP for this game is $34.99.

Fans of Lucasarts' first two Monkey Island games will find more of the same good fun in *The Curse of Monkey Island.* This time buccaneer LeChuck is attempting to woo Elaine into becoming his undead bride. But a cursed ring slipped on her finger turns her into a gold statue. LeChuck must find a way to remove the curse while battling villains and pirates. This third installment of the Monkey Island game series has players finding objects and solving puzzles in order to finish the game. This installment costs about $39.95 ESP.

Activision's *Zork Grand Inquisitor* centers around restoring magic to the ailing Great Underground Empire so its inhabitants may be freed from the Dark Ages of Zork. Magic has been outlawed, so players must join forces with the Magic Resistance to battle the Grand Inquisitor's regime. Players travel back to classic Zork eras to recover three magical treasures—the Skull of Yoruk, the Cube of Foundation, and the Coconut of Quendor. *Grand Inquisitor* has a suggested retail price of $49.95.

Also from Activision comes *Dark Reign* (MSRP of $49.95), a sci-fi adventure where two armies duel for interplanetary domination. Set in a distant future, players are immersed in a struggle of war, loyalty, and rebellion. Another game from Activision, *Net Storm,* integrates leading-edge game design and sophisticated online capability. The MSRP is $39.95.

VtechSoft's *Book Buddies* presents classic animated tales to children ages 4 to 7. The CD-ROM features Jack & the Beanstalk, The Three Little Pigs, Three Billy Goats Gruff, and Little Red Riding Hood. The package also includes a $5\frac{1}{2}$-inch plastic figurine character from each story. The characters stand on top of a speaker base that plugs into your sound card, and your PC speakers plug into the base. Somehow the base cuts out the signal going to your speakers at times, and only the character speaks with its voice coming from the base. Kids can also print coloring books, board games, and recipes. *Book Buddies* costs $39.95.

That's about it for this month—see you in my next column. ■

COMPUTER BITS

(continued from page 43)

lock bits can only be erased (thereby unlocking program memory) via a Chip Erase operation, which can only be performed in parallel programming mode.

The hardware required to implement either serial or parallel programming is simple. In fact, it is possible to implement programming solutions simply by connecting the appropriate lines of the 1200 to the correct pins of a standard serial or parallel port. Not to forget software, of course—details on this next time.

FOR MORE INFORMATION

Atmel Corporation
2325 Orchard Parkway
San Jose, Ca 95131
Tel. 408-441-0311
Web: *www.atmel.com*

MVS
Box 850
Merrimack, NH 03054Tel. 508-792-9507
Web: *www.star.net/people/~mvs*

COMPETITION

The 1200 competes against the PIC family by providing in-circuit programming, more versatile memory, more registers, more I/O, and higher speed. Architecturally, the 1200 is simpler. For example, PICs typically require bank switching to access various memory pages; the 1200 provides free access to all memory at all times.

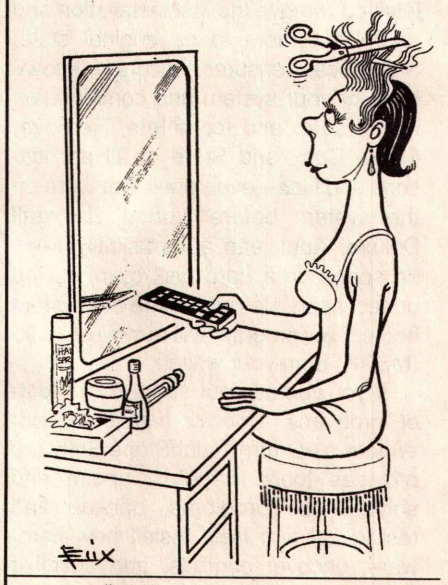
On the other hand, PICs have plain RAM for temporary storage. However, the 1200's 32 registers compensate pretty well for that. The 1200's 64-byte EEPROM space might seem comparable, but it cannot be accessed at clock speed; typical read and write time runs 2–4 ms, depending on supply voltage. PICs also have an eight-level stack (whew!), as compared with the 1200's three-level stack.

It seems that every microcontroller must have some curious architectural lapse. So far, the only one I've found for the 1200 is that it has no command to load a register from program memory. It can load an "immediate" value, which is really encoded by an assembler as part of the opcode. But there is no way to create a table of data and index through it. That is a bad characteristic. Why, with so much else going for it, would the designers of this chip do such a thing? Ah well.

WHERE DO I GET IT?

Sound good? I thought so. Now you want to know how to buy one. Getting an Atmel chip may not be so easy. However, a company called MVS is selling, in small (and large) quantities, a variant known as the *MVS1200.* According to an MVS spokesperson, the MVS1200 is "backwards-compatible" with Atmel's variant. Both devices are based on the same basic design; the MVS version adds a few instructions, but is otherwise totally compatible. We'll be looking more at the differences in future installments; for now, the MVS1200 will suit our purposes just fine. The MVS1200 comes with RCEN programmed, so you can literally apply power and run the chip. Contact MVS directly for details and ordering information.

Also, check Atmel's Web site at *www.atmel.com* for data sheets and application notes. MVS's documentation is Spartan at best, but the Atmel information is pretty well done. See you next time. Meanwhile I will be posting information and links on my Ingeneering Web site *(www.ingeninc.com),* or contact me at jeff@ingeninc.com. ■



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NET WATCH

Sites for Movie Buffs

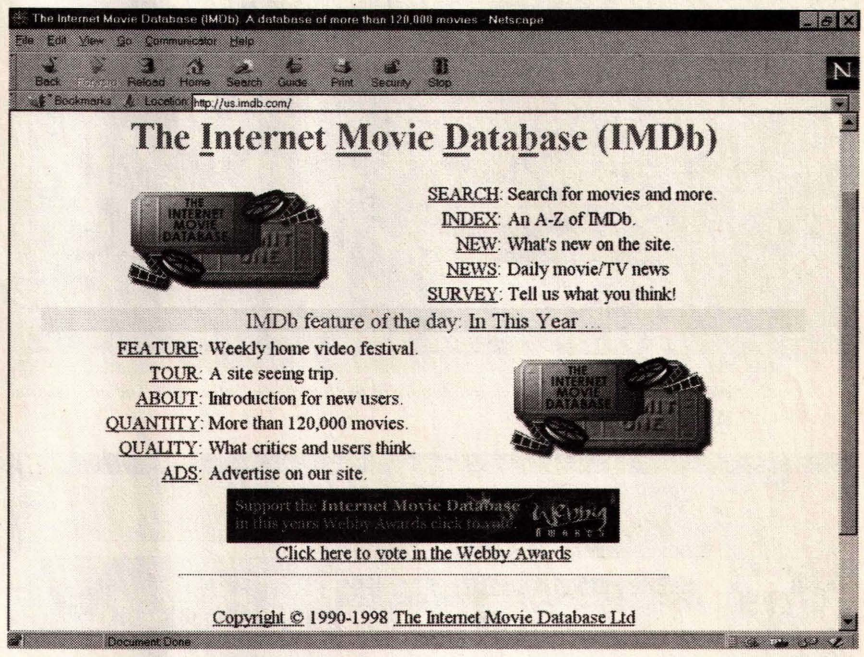
KONSTANTINOS KARAGIANNIS

We all love movies right? They're a part of our pop culture, an integral piece of our history, and a perfect way to tell a story in a dramatic way. And, oh yeah, there are a *lot* of them out there. Whether you're planning on doing the whole dinner-and-a-movie outing, trying to decide which summer blockbuster to see, or just want a good video to rent, you could easily find yourself overwhelmed with all the choices. Friends' recommendations can only go so far, no?

This month we'll take a look at some great sites on the Net that are so full of film information, it would take an entire lifetime to read just a fraction of the information found on them! And, as films keep coming out, the sites are being updated.

Want to see what movies a particular actor is in? Enjoy a particular director's style and feel like checking out his or her other work? You'll be amazed at how easy the Web makes tasks like these. Further, as we hinted at a moment ago, deciding what movie to see can be difficult at times. That's where reviews come in. Sure, new films are reviewed in just about every newspaper, but what about the ones you missed in the theater?

Enough preamble, though, Hollywood's a fast-paced place, so let's get rolling!


The Internet Movie Database (IMDb): A database of more than 120,000 movies - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Location: http://us.imdb.com/
The Internet Movie Database (IMDb)
SEARCH: Search for movies and more.
INDEX: An A-Z of IMDb.
NEW: What's new on the site.
NEWS: Daily movie/TV news
SURVEY: Tell us what you think!
IMDb feature of the day: In This Year ...
FEATURE: Weekly home video festival.
TOUR: A site seeing trip.
ABOUT: Introduction for new users.
QUANTITY: More than 120,000 movies.
QUALITY: What critics and users think.
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Document Done

It may not look like much at first, but the Internet Movie Database houses more film information than you could read in a lifetime.

INTERNET MOVIE DATABASE

While there are few sites you can say this about, I find myself tempted to say this of the Internet Movie Database (or IMDb)—if you can't find it here, it might not be out there.

This is the absolute largest database of film information on the Internet and is basically the first place I ever look if I want to know who was in what, *etc.* The opening page might not look like a whole lot graphically, but the site makes up for it with a killer amount of info. As it says at the top of the home page, the site has data on over 120,000 movies! I found it hard to believe there were even that many films in existence when I first read the figure.

Like all good databases, online or not, the IMDb has an excellent search engine. Click on Search and choose what type of information you are looking for. You can enter title words, actors, directors, and even genre with an amazing amount of specificity allowed (*i.e.*, you can type in "vampire movie" and not just "horror").

When you finally find the movie you're looking for, you'll usually find that there's a plot synopsis/review. A few obscure movies don't have this, but you could always add your own. Some of the descriptions are a little vague, but as we just implied, they aren't written by pros. Anyone can submit opinions and corrections. It's amazing all the fine details the site crams into each film's description. You can learn the name of most everyone in the cast, and even find out who the people behind the scenes were.

Next time someone tells you there was this great action movie with so-and-so in it, that came out in such-and-such a year, look no further than the IMDb. I don't think I've ever been able to stump it with a query, and I've searched for some pretty bizarre low-budget films, too.

Finally, there's a neat rating system used at the site. Rather than accepting what one critic decided should be the film's star rating (for example, five stars for excellent), the site uses a one through ten system based on people's votes. Could the majority be wrong about a film? Well, okay, they could be, but it's still safer than trusting one person.

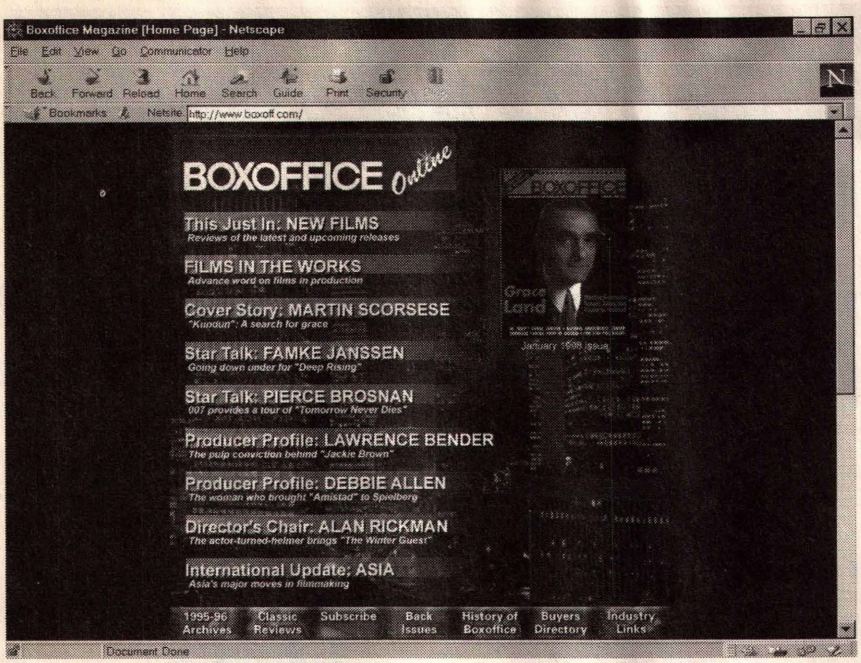
The biggest drawback to the site is it doesn't have any images. In this mul-

HOT SITES

Internet Movie Database
www.us.imdb.com

Boxoffice Online
www.boxoff.com

99 Lives: The Video Magazine
www.99lives.com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Advance word on films in production
Cover Story: MARTIN SCORSESE
"Kundun": A search for grace
Star Talk: FAMKE JANSSEN
Going down under for "Deep Rising"
Star Talk: PIERCE BROSNAN
007 provides a tour of "Tomorrow Never Dies"
Producer Profile: LAWRENCE BENDER
The pulp conviction behind "Jackie Brown"
Producer Profile: DEBBIE ALLEN
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Director's Chair: ALAN RICKMAN
The actor-turned-helmer brings "The Winter Guest"
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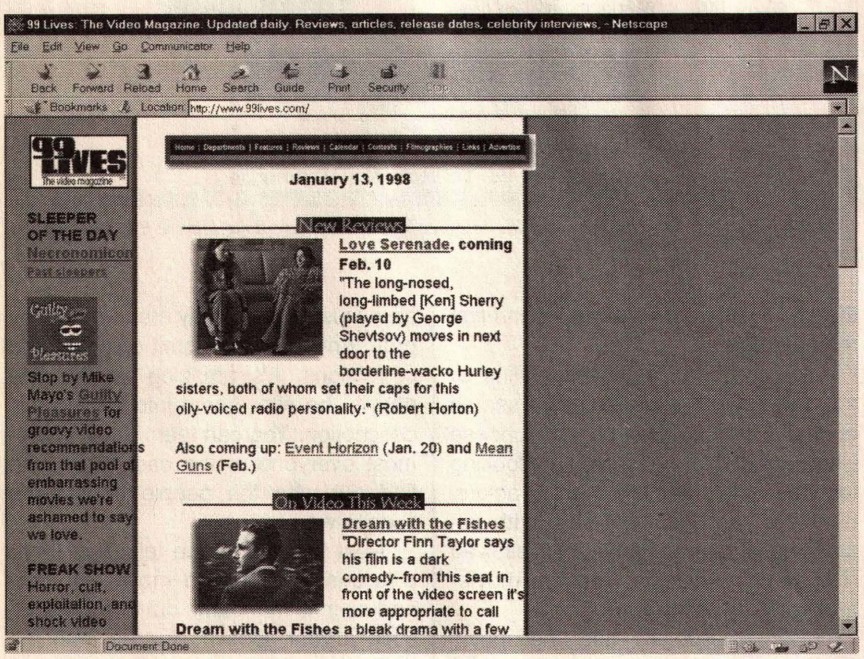
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99 LIVES
The video magazine
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January 13, 1998
SLEEPER OF THE DAY
Necronomicon
Past sleepers
Guilty Pleasures
Stop by Mike Mayo's Guilty Pleasures for groovy video recommendations from that pool of embarrassing movies we're ashamed to say we love.
FREAK SHOW
Horror, cult, exploitation, and shock video
New Reviews
Love Serenade, coming Feb. 10
"The long-nosed, long-limbed [Ken] Sherry (played by George Shevtsov) moves in next door to the borderline-wacko Hurley sisters, both of whom set their caps for this oily-voiced radio personality." (Robert Horton)
Also coming up: Event Horizon (Jan. 20) and Mean Guns (Feb.)
On Video This Week
Dream with the Fishes
"Director Finn Taylor says his film is a dark comedy--from this seat in front of the video screen it's more appropriate to call Dream with the Fishes a bleak drama with a few
Document Done

For those who like to watch movies at home, 99 Lives: The Video Magazine is the site to visit. You'll find release dates, reviews, and articles about the people making movies of all types and budgets.

timedia age, Web surfers just love eye candy or maybe even sound clips. But we'll give the Database a little leeway here—housing multimedia files for over 120,000 movies would challenge even the most impressive Web servers.

BOXOFFICE ONLINE

Sometimes you want deeper information about movies than just who's in them. Want to get more of an inside track to what's happening in Hollywood, check out Boxoffice On-line, the Web presence of *Boxoffice* magazine. The site contains most of the content from the past three years' worth of issues. Each online issue has articles about up-and-coming films (the link called FILMS IN THE WORKS), and the ones making news today (click NEW FILMS). The Cover Story focuses on a big name or big movie phenomenon in the industry. Star Talk articles are interviews with actors, while Producer Profile and Director's Chair are chats with, well, producers and directors.

If you don't feel like searching through past issues online, you can simply go to the 1995–1997 Review Archives. Or, to speed things up even more, try the downloadable Infoscout software. It's an offline movie-review browser that works with *Internet Explorer*. New reviews are automatically downloaded regularly into the program, allowing you to search reviews offline at your leisure. The Infoscout software and service is free for 30 days and then costs a one-time license fee of $14.95.

99 LIVES

A similar site to Boxoffice Online is 99 Lives: The Video Magazine. As you might have gathered from the title, there is a significant difference between the two—99 Lives is devoted to movies that are now available on videotape, laser disc, and DVD.

Here's the perfect site to consult before heading out to the video store. Most useful is the site's Calendar, which tells you what movies are coming out on video on what day. It looks as if the site gets its information rather quickly and updates it frequently. In other words, if a release date has been set for a particular title, there's a good chance you'll learn about it here. To help you pick which of these new releases (or old ones) you should get, the site also has Reviews. They're written in a more, shall we say, "hip" style than Boxoffice.

The Features here might seem dated in that they're articles about movies that came out half a year to several years ago, but remember, this is a video magazine. When you head out to *Blockbuster*, you're not looking for information about what's in the theaters. And the Features are pretty interesting. They're usually relevant to the week's new releases, and I think they do a good job of generating a fresh interest in movies just coming out on video.

Some of the articles even deal with technology. I also liked the non-techie Wish List, which is a list of hard-to-find favorites on video and how you can go about actually finding them.

Until next time, hope you have some good experiences checking out the big screen and avoiding the box-office flops. Feel free to e-mail me at netwatch@comports.com or send snail mail to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

The Quad Loop Revisited

JOSEPH J. CARR

The quad loop antenna (Fig. 1) is a square loop that can be fed on either a horizontal edge (horizontal polarization) or vertical edge (vertical polarization). This type of loop is a "large loop" because it has an overall perimeter of at least one-half wavelength at the frequency of interest. When the loop is this size, the current in the loop is not constant, but rather varies over the length of the wire (as does the voltage). The example shown in Fig. 1 has a total length of 1λ, and is positioned for horizontal polarization.

These antennas were developed in the late 1930s and continue to be popular today. The large loop came into prominence when Clarence Moore, an engineer at missionary shortwave radio station HCJB in Quito, Ecuador, tried to solve a problem with arcing off the ends of half wavelength elements used in Yagi beams. The thin air of the mountain location of HCJB caused corona to develop, and it destroyed the tips of the antenna elements. The antenna designed by Moore was a two element beam made of square quad loops.

Large loop antennas are commonly found in circular, triangular, and square geometries. The square loop is shown here and is the subject of this column; it is probably the most popular because of its relative ease of construction. It has a gain slightly less than 1.8 dB above isotropic (dBi), which means that it exhibits a bit less than the gain of a half wavelength dipole. The feedpoint impedance is close to 110 ohms. The performance difference between square and circular form factors is small, so it is common in antenna engineering books to see the circular analysis being used as an approximation for the square analysis.

The quad loop also produces (like the dipole) a figure-8 azimuthal pattern, and, at higher frequencies, can be easily made rotatable.

FEEDING THE QUAD LOOP

There are two basic feed configurations for the square loop (Fig. 2). In each case, the loop is fed in the center of one side, which becomes a *de facto* current node. The other current node will appear at the middle of the opposite length, while the voltage nodes appear at the middle of the adjacent lengths. If horizontal polarization of the antenna is preferred, then feed the antenna along either the top or bottom horizontal length (Fig. 2A). Alternatively, vertical polarization occurs when the antenna is fed along either vertical length (Fig. 2B).

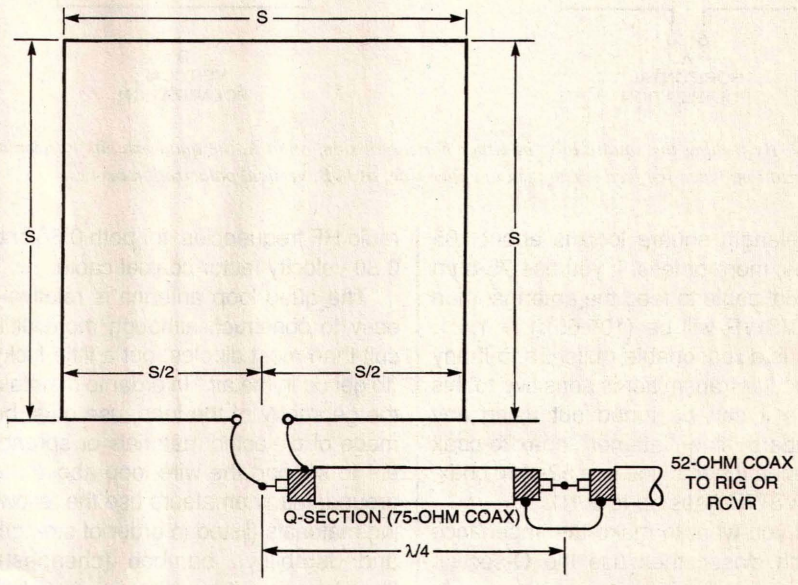

Fig. 1. The one wavelength quad loop antenna is horizontally fed and uses a (λ/4) Q-section for matching to 52-ohm coax transmission line.

The feedpoint impedance of the 1λ loop varies from about 100 ohms to 130 ohms. If we feed these antennas directly with 75-ohm coaxial cable, the VSWR will vary from 1.33:1 to 1.7:1. This range is well within what is normally acceptable for a receiver, and with a line flattener antenna tuning unit (ATU), this antenna can be used with a transmitter.

Because the feedpoint impedance of the square loop is a bit over 100 ohms, using 75-ohm coaxial cable in a "Q-section" (or quarter-wave section of electrical length λ/4) impedance transformer, creates a decent match to 52-ohm coaxial cable. The coaxial cable is connected to the center point of the bottom edge (the top edge could also be used). The center conductor of the coax is connected to one side of the loop, while the shield of the coax is connected to the other side of the loop.

The length of each side (S in Fig. 1) is one-quarter wavelength, so the overall length, or perimeter (L), is one wavelength (L = 4S). This antenna can be built using 14 gauge copper antenna wire. The values of the lengths are:

$$L = 1005/f_{MHz}$$

$$S = L/4 = 251.25/f_{MHz}$$

If you don't care to calculate the lengths, then values across the HF amateur bands are given in Table 1. The values for the sides (S), and overall length, L, where L = 4S, are listed (in feet) every 250 kHz. If you want to pick a frequency between these values, then interpolate (split the difference proportionally).

Q-SECTION IMPEDANCE TRANSFORMER

The feedpoint impedance of the one

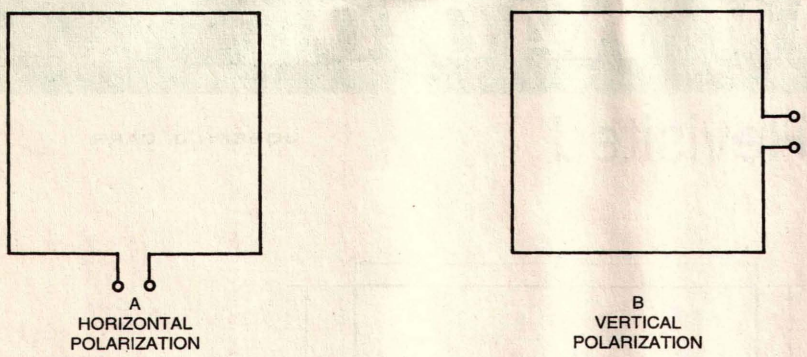

Fig. 2. By feeding the square loop in either horizontal side, as in A, the quad exhibits horizontal polarization; when the feed is changed to either side, as in B, vertical polarization occurs.

wavelength square loop is about 105 ohms, more or less. If you use 75-ohm coaxial cable to feed the antenna, then the VSWR will be (105/65):1 = 1.4:1. This is a reasonable match, and if any particular transmitter is sensitive to this value it can be tuned out using any standard "line flattener" coax-to-coax antenna tuner. If you use 52-ohm coax, the VSWR goes up to 2.1:1.

If you want to make the impedance match closer, then use the Q-section impedance transformer as shown in Fig. 1. The value of the Q-section characteristic impedance is 75 ohms, and the impedance of the line to the transmitter or receiver is 52 ohms. For any Q-section, the value of the impedance required of the coax is:

$$Z_S = \sqrt{Z_O Z_L}$$

where

Z_S is the impedance of the Q-section coax

Z_O is the impedance of the coax to the rig

Z_L is the feedpoint impedance of the antenna

If you work the numbers with Z_L = 105 ohms, and Z_O = 52 ohms, then the value required of the Q-section (Z_S) is 73.9 ohms, which is close enough to 75 ohms to be considered "right on."

The electrical length of the Q-section is one-quarter wavelength at the frequency of interest. The physical length, however, is a bit less because of the velocity factor of the coaxial cable used for making the Q-section. The velocity factor of polyethylene dielectric coax (the oldest form) is 0.66, while for polyfoam dielectric it is 0.80. Table 2 shows the physical lengths (in feet) for Q-sections at some amateur radio HF frequencies, for both 0.66 and 0.80 velocity factor coaxial cable.

The quad loop antenna is relatively easy to construct, although more difficult than most dipoles, but a little tricky "to get up in the air." In order to maintain the geometry of the loop, use must be made of dielectric materials or spreaders to support the wire loop above the ground. Many amateurs use the following materials (listed in order of strength and durability): bamboo (cheapest), fiberglass (most popular), or "surplus" pole-vaulting poles (expensive and difficult to find).

THE CUBICAL QUAD BEAM

The quad loop antenna can be formed into a beam antenna by adding a second element. Two forms of constructions are seen, although one is more common than the other. The most common form (Fig. 3) places a second element, a parasitic element, in front of, or behind, the *driven element* (which is like Fig. 1). If the parasitic element is in front of the driven element (Fig. 3A), then it is a *director*, and is about 3 percent shorter than the driven element. If the additional element is placed behind the driven element (Fig. 3B), then it is called a *reflector* (about 3 percent longer than the driven element). In both Figs. 3A and 3B the direction of radiation is shown by the arrow.

The other method of construction places the two loops side-by-side and feeds them in parallel, but 180° out of phase. The loops are generally fed from a 1:1 balun transformer through equal lengths of 300-ohm twin-lead transmission line. Twist the line once on each end to provide the phase reversal.

Put all these three elements together (reflector, driven element, director) and you have a 3-element quad beam—which some hams say works better than a 4-element Yagi beam.

TABLE 1—QUAD LOOP DIMENSIONS (FEET) VS. FREQUENCY

f_{MHz}	L	S
7.00	143.57	35.89
7.25	138.62	34.66
7.50	134.00	33.50
10.00	100.50	25.13
10.25	98.05	24.51
14.00	71.79	17.95
14.25	70.53	17.63
14.50	69.31	17.33
18.00	55.83	13.96
18.25	55.07	13.77
21.00	47.86	11.96
21.25	47.29	11.82
21.50	46.74	11.69
24.75	40.61	10.15
25.00	40.20	10.05
28.00	35.89	8.97
28.25	35.58	8.89
28.50	35.26	8.82
28.75	34.96	8.74
29.00	34.66	8.66
29.25	34.36	8.59
29.50	34.07	8.52
29.75	33.78	8.45

MY HOBBY HORSE

If you have read my columns over the years you know that I am fond of science fairs for high school and junior high school students. When I was in 7th through 12th grades I entered science fairs (and even took some "paper" home). I now judge science fairs, have counseled a couple of science fair students, and generally support the science fair movement. Recently, a fellow contacted me about the general lack of electronics science fair projects. He is the coordinator of an eight-school district area fair, and a ham radio operator. Although there are lots of computer projects (mostly programming), if it is like our local fair, the number of electronics projects entered is diminishing year after year.

What to do about it? If you are a teacher, or have some other role in the local middle and high schools, then encourage students. If you are a parent or friend of a youngster in the correct age range, then you can also encourage them—and within the limits of the

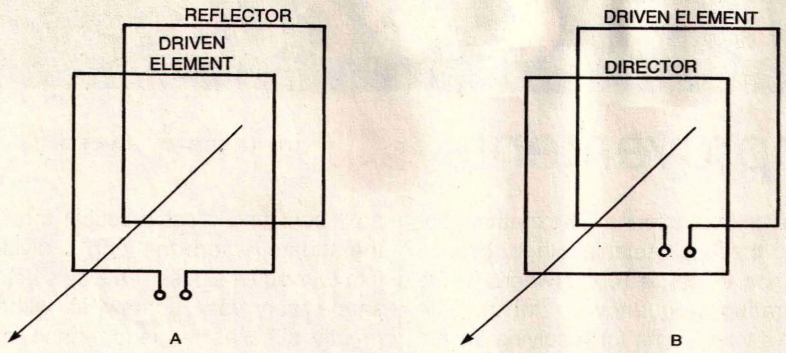

Fig. 3. A two-element cubical quad antenna consists of the driven element and a parasitic element. When the parasitic element is placed in back of the driven one, as in A, it is called a reflector. With the parasitic element placed in front, as in B, it is called a director. Electrical characteristics of both configurations are essentially the same—main beam is perpendicular to the plane of the loops in the direction shown.

TABLE 2—Q-SECTION LENGTH (FEET) VS. FREQUENCY

f_{MHz}	V = 0.66	V = 0.80
7.00	23.19	28.11
7.25	22.39	27.14
7.50	21.65	26.24
10.00	16.24	19.68
10.25	15.84	19.20
14.00	11.6	14.06
14.25	11.39	13.81
14.50	11.20	13.57
18.00	9.02	10.93
18.25	8.90	10.78
21.00	7.73	9.37
21.25	7.64	9.26
21.50	7.55	9.15
24.75	6.56	7.95
25.00	6.49	7.87
28.00	5.80	7.03
28.25	5.75	6.97
28.50	5.70	6.91
28.75	5.65	6.85
29.00	5.60	6.79
29.25	5.55	6.73
29.50	5.50	6.67
29.75	5.46	6.62

rules—assist them in designing and executing a project. This year's science fair season is over by only a few weeks, but the time to start a youngster planning for next year is just beginning.

Even if you are not a teacher or parent of science fair age kids, you can still assist. Contact the science department of your local school, or the science (or science fair) coordinator of your local school board. Schools rarely shun volunteers who want to serve as advisors or judges.

It is no secret that amateur radio is seeing declining numbers, and that the average age of ham operators is increasing (my average age is certainly increasing!). Technically inclined kids today gravitate towards computers rather than ham radio. Perhaps encouraging the kids to do electronics projects, or better yet radio projects, will help some of them see ham radio as a potential hobby.

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrjj@aol.com. ■

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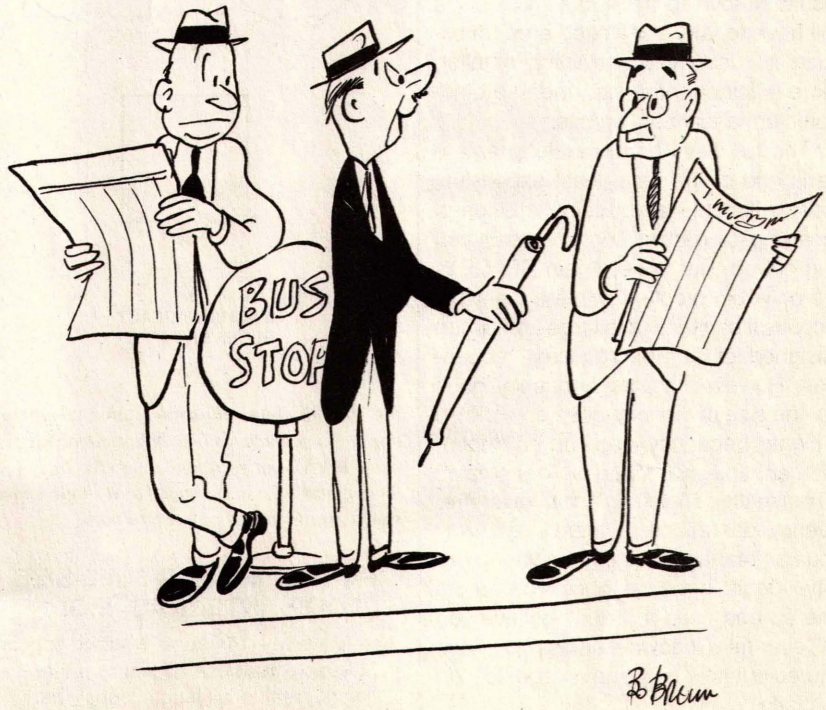


"To satisfy my taste for adventure, I roam the Internet."

CIRCUIT CIRCUS

AM Reception Improvements

CHARLES D. RAKES

Circuiteers, get ready for some radio fun and adventure here at the *Circus,* as we look over a number of loop antennas, pre-amps, and other receiver enhancement circuits. There's no limit to the information that's flowing around us everywhere in the radio medium, and the easiest way to experience the adventure is on the standard AM broadcast band, where thousands of stations are operating. But, by no means do you have to limit yourself to this very small segment of the radio spectrum. There is information abound from near-audio frequencies to light waves that are just waiting to be tapped. Radio monitoring is a giant wide-open hobby that can supply hours and hours of fun and adventure to all. Buckle your seat belts, and make ready for a journey into radio wonderland!

FULL-SIZE LOOP ANTENNAS

To capture all those radio waves we need antennas, and antennas require a lot of space. Space is the basic requirement for that dream antenna farm we would all love to have, but most of us will have to take our limited area; maximize its use by constructing smaller, more efficient antennas; and use electronic enhancement circuits.

The full-wave horizontal loop antenna is one of the best, least expensive, most efficient, and quiet, multiband receiving or transmitting antennas you can put up. Bar none! Again SPACE is the only real problem with the full-wave loop, as it can take up a large area when designed for the AM broadcast frequencies. However, as the frequency goes up, the size of the loop goes down. Also a higher frequency loop can be "tuned" with an antenna tuner or Transmatch ("Transmitter Matching") for lower frequency operations. If there's any way you can manage to fit one on your property—do it, because once you've put one up and used it, I don't believe you will ever take it down—unless you have figured out how to put up a larger loop in its place.

Figure 1A shows the basic full-wave circular loop antenna. The math for figuring the loop's total length, or circumference, in feet, is $1005/f$ (where f is the operating frequency in MHz). The loop's total length for receiving an AM broadcast station operation on a frequency of 1 MHz would be 1005/1, or a total loop circumference of 1005 feet! Granted this would not be practical in most cases, but if the frequency you wanted to receive happened to be 10 MHz, the total length of the loop would be a manageable 100.5 feet. Since it's configured as a square loop, we divide this length by four (see Figure 1B), and each side only takes up about 25 feet —also do-able.

The ideal construction form for the loop would be a circle, but that is not practical because it would take an infinite number of supports around the loop to maintain the circle pattern. The next best and most practical form is the square, where the loop is divided into four equal sides. The loop's actual shape can vary somewhat without greatly affecting its performance, and the feed point can be in any of the corners as well.

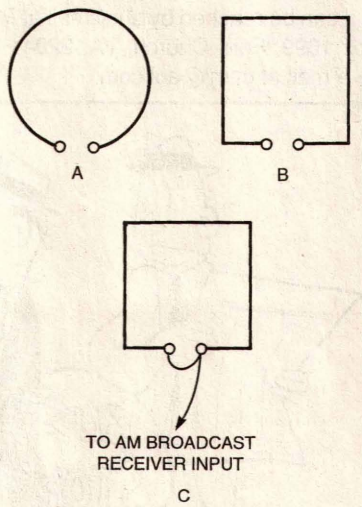


Fig. 1. This figure illustrates three configurations of loop antennas. The balanced loop is circular in (A) and rectangular in (B). In (C), a rectangular loop is shown fed as a single-ended source using ground as a return path.

PARTS LIST FOR FULL-SIZE LOOP ANTENNAS (FIG. 1)

Antenna wire—14-gauge, 7-strand copper (Radio Shack has 70-foot rolls that work great in full-length loops—part number 278-1329)

I've seen some small lots with a full 80-meter loop and a very small lot supporting a full 40-meter loop. To make it fit on your property, you can even have your house in the middle of the loop. The higher up you place the loop the better it works, but don't let that bother you too much—my full-length, 80-meter loop is only about 15 feet above ground, built on a slope where it performs like gangbusters on all the HF ham bands.

The loop can be used on lower bands and even the AM broadcast band, by tying the ends of the loop together and feeding with a single wire to the receiver's antenna input (see Fig. 1C).

SMALL LOOP

If you have never played with loop antennas, the one shown in Fig. 2 is a good one to try first. This indoor loop may be wound on the outside of a door facing, or supported in mid-air from the ceiling, or any other method you chose. The dimensions and number of turns are not set because it is not likely that any two would be the same. No matter what support method you use, try and keep it away from metal objects; so don't use a door facing that surrounds a metal door. If a door facing is the winding support, try about four turns of any size insulated wire from #12 to #26 gauge.

Connect both sections of an old radio broadcast tuning capacitor (365-pF or larger) in parallel and across the coil. Then place a plastic case AM transistor radio in the loop so the radio's internal loop is parallel to the large loop. Tune the radio to a weak station anywhere in the mid-dial position and adjust the large loop's capacitor for maximum audio output. If the loop's tuning range covers the frequency your radio is tuned to, the audio output and quality will greatly be

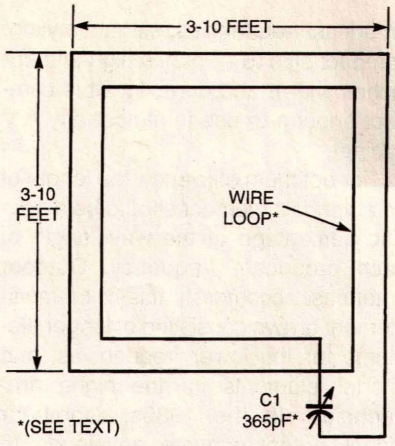


Fig. 2. This indoor loop can be wound on the outside of a door facing or supported in mid-air from the ceiling. It will work wonders in improving AM reception.

PARTS LIST FOR SMALL LOOP ANTENNA (FIG. 2)

Antenna wire—Any size copper wire from #12 to #26 gauge
C1—365-pF or larger tuning capacitor

enhanced. If the loop and capacitor combination won't tune to the radio's frequency, the loop's induction might be too small or not have enough turns. Either add a turn or add a 330-pF capacitor across the coil and retune.

SMALLER, ACTIVE LOOP CIRCUIT

Our next loop in Fig. 3 is smaller—and to help make up for its reduced size, an RF amplifier is added. The loop is five turns of #22 plastic insulated copper wire, close wound on a 3-foot diameter wood frame. If a circle frame is not available, use a 3-foot square wood frame. The tuning range will depend on the loop's actual size and the value of capacitance of C1. One of the old AM tube-type tuning capacitors (365-pF or larger) with two variable sections tied together is an excellent choice for C1. If a large value tuning capacitor is not available, additional capacitance can be switched across the loop to lower the tuning range. Add capacitance in steps of about 330 pF to cover the lower frequency range of the AM broadcast band.

Transistor Q1, a MPF102 FET, amplifies the tuned RF signal, and its output is buffered by Q2, a 2N2222 transistor, connected in an emitter-follower circuit. Resistor R2 sets the gain of the RF amplifier and drives the signal into the receiver's antenna input terminal.

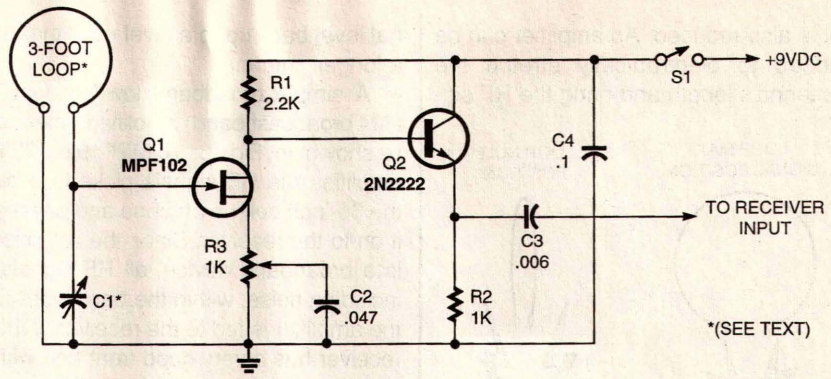


Fig. 3. Short of antenna space? Try this active antenna circuit. The RF amplifier boosts up the gain to reasonable levels.

The amplified loop is best used with a radio that has an external antenna input, but if it doesn't, connect the output to a pull-up antenna. If the receiver has neither an external antenna input or a pull-up antenna, add the coupling coil shown in Fig. 4.

The actual size and number of turns on L1 isn't too important, but the type of ferrite used should be of the same material as found in most AM transistor radios. The ferrite core can be salvaged from most any non-working transistor portable radio. It can be either a round or rectangle-shaped core.

Align the coupling coil on the outside of the radio's case in parallel with the radio's internal antenna coil. Locating L1 for its best position should be done when receiving a weak signal. Move L1 around the area where the radio's internal loop is located and tape it in place where the greatest output signal is produced.

GETTING THE MOST FROM YOUR AMPLIFIED LOOP

The loop should be positioned vertically to match the polarization of the AM broadcast stations and aimed with the plane of either side of the loop toward the station you want to receive, as shown in Fig. 5A. One of the loop's best features is its ability to null out noise and unwanted stations. Select a station that you don't want to receive and rotate the plane of the loop perpendicular to the direction of that station, and the signal will null to a low signal level (see Fig. 5B). Also the loop may be tilted to help in nulling unwanted signals as well as increasing desired ones.

MICRO-ANTENNA FOR LONGWAVE RECEPTION

As the length of an antenna is reduced, the signal sent to the receiv-

PARTS LIST FOR SMALLER, ACTIVE LOOP CIRCUIT (FIG. 3)

C1—365-pF or larger tuning capacitor
C2—0.047-μF, 50-WVDC, ceramic-disc or similar capacitor
C3—0.005-μF, 50-WVDC, ceramic-disc or similar capacitor
C4—0.1-μF, 50-WVDC, ceramic-disc or similar capacitor
Q1—MPF102 JFET (RadioShack 276-2062, or equivalent)
Q2—2N2222 NPN transistor (NTE123A, SK3444, or equivalent)
R1—2200-ohm, 1/4-watt, 5% resistor
R2—1000-ohm, 1/4-watt, 5% resistor
R3—1000-ohm potentiometer
S1—SPST switch
Antenna loop—see text

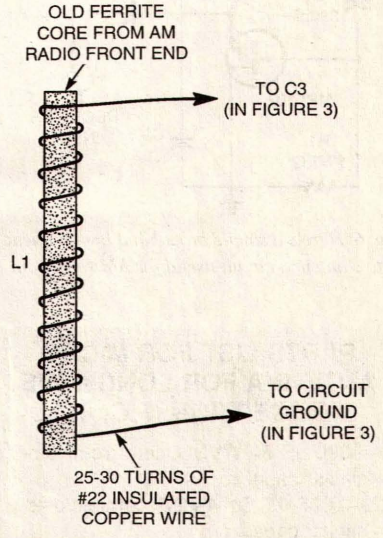

OLD FERRITE CORE FROM AM RADIO FRONT END
TO C3 (IN FIGURE 3)
L1
TO CIRCUIT GROUND (IN FIGURE 3)
25-30 TURNS OF #22 INSULATED COPPER WIRE

Fig. 4. Without an external or pull-up antenna? Use this coupling antenna as an alternative.

PARTS LIST FOR COUPLING COIL (FIG. 4)

L1—Old ferrite loop core removed from AM transistor radio (see text)

er is also reduced. An amplifier can be added to electronically stretch the antenna's length and bring the RF signal level back up to a level near that of a longer antenna.

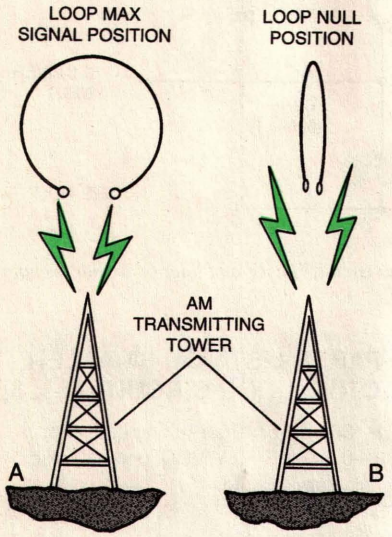


Fig. 5. This figure illustrates the proper positioning for a loop antenna. In (A) when the loop antenna is broadside (maximum area exposed to the incoming RF energy), the reception will be maximized. As the plane of loop is rotated 90 degrees, as in (B), the signal strength is minimized, or nulled out.

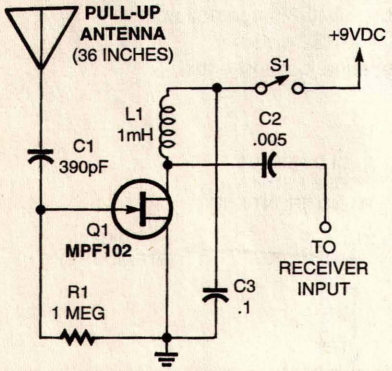


Fig. 6. Here's a simple broadband low-frequency active antenna circuit useful for AM reception.

PARTS LIST FOR MICRO ANTENNA FOR LONGWAVE RECEPTION (FIG. 6)

C1—390-pF, 50-WVDC, ceramic-disc or similar capacitor
C2—0.005-μF, 50-WVDC, ceramic-disc or similar capacitor
C3—0.1-μF, 50-WVDC, ceramic-disc or similar capacitor
Q1—MPF102 JFET (RadioShack 276-2062, or equivalent)
L1—1-mH RF choke
R1—1-megohm, 1/4-watt, 5% resistor
S1—SPST switch
Antenna—36-inch pull-up replacement antenna

A simple broadband low-frequency (AM broadcast band) amplified antenna is shown in Fig. 6. A MPF102 JFET amplifies the RF signals picked up by the 36-inch pull-up antenna and passes it on to the receiver. Since the amplifier is a broadband device, all RF signals, including noise, within the bandwidth of the amplifier is fed to the receiver. If the receiver has a very good front end with excellent selective and dynamic range, the amplifier will help. But if the receiver happens to have a weak front end, look out; the amplified antenna could cause more grief than good.

In any case, the circuit won't cost you too much to build. Experiment with it to see if it can help pull in that desired AM station. The amplifier's gain can be changed somewhat by raising and lowering the pull-up antenna. This could allow the amplifier to be used with a low-cost receiver.

Looks like it's time to go, so until next month—great listening on the AM band. ■

NEW PRODUCTS

(continued from page 38)

The small, thin style of the meters makes them easy to carry in tool belts or to fit easily into tool boxes. They measure approximately 6 3/4-inches high by 1 5/8-inches wide at the widest point. Designed especially for electricians, plant and maintenance engineers, and other who need a compact tool, Wavetek's ST75 and TM45 are very useful for applications where space is tight, for quick tracing on wiring panels and circuits, and for blower and motor circuit troubleshooting.

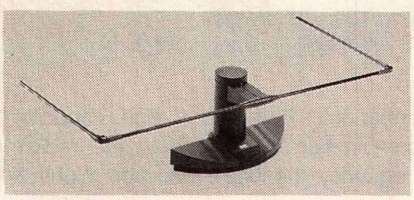
Priced at $99.95, the meters come complete with batteries, test leads, probes, and a protective carrying case and are available from local distributors and national catalogs. Contact Wavetek Corporation, Instrument Division, 9405 Balboa Avenue, San Diego, CA 92123; Tel. 619-279-2200; Fax: 619-565-9558.

CIRCLE 86 ON FREE INFORMATION CARD

MODERN RABBIT-EAR ANTENNA

The *TV15* from *TERK Technologies* offers the ideal combination of exceptional reception performance on all TV broadcast frequencies, elegant styling, compact-size (5 1/4-inches high and 25-inches wide), and durability. It is compact enough to use in almost any A/V cabinet.

For optimum efficiency, the length of an antenna's element should be a specific percentage of the wavelength of each broadcast frequency. Outdoor antennas accomplish this with multi-element arrays consisting of longer elements for the lower frequencies, and shorter elements for the higher frequencies. In the 1930s, rabbit-ear indoor antennas were developed to duplicate the physics of the outdoor antenna by permitting the user to physically vary the length of the two telescoping arms. However, rabbit ear antennas have inherent problems. TERK has developed the TV15 to resolve these problems.



This horizontally arrayed non-telescoping dual-rod antenna utilizes newly developed Advanced Frequency Matching Technology, which involves the use of tuned circuits in each arm of the TV15. These circuits extend the effective length of each arm electrically at the lower frequencies, while reducing their effective length for reception of higher frequencies. For even greater efficiency and selectivity, TERK added an additional stage of Pin-Dot Pre-Tuning. Adjustable via a five-position switch on the antenna base, the Pre-Tuning stage enables the user to minimize ghosting and other artifacts in difficult reception conditions. The semi-circular base has a curved surface that allows easy access to the Pin-Dot Pre-Tuning control and the Antenna/Video source selector. The two-position source selector makes it easy to switch between off-air reception and other video sources, such as satellite, video games, or camcorders.

The TV15 retails for $39.95. Contact TERK Technologies, 63 Mall Drive, Commack, NY 11725; Tel. 516-543-1900; Fax: 516-543-8088; Web: *www.terk.com.*

CIRCLE 87 ON FREE INFORMATION CARD ■

Think Tank

Something for Everyone

ALEX BIE

In this month's column, we continue exploring the basics of electrical devices—namely the semiconductor. One of the fundamental structures within semiconductor technology is the PN junction (see Fig.1). It has the valuable property that electrons only flow in one direction across it, and as a result, it acts as a rectifier. This means that the PN junction is widely used both with integrated circuits and also as a discrete device for more conventional circuits.

WHAT IS A PN JUNCTION?

In its basic form a PN junction is manufactured from one piece of semiconductor material by making one end P-type and the other end N-type. This means that both ends have different characteristics. One end has an excess of electrons while the other end has a surplus of holes. Where the two areas meet, the electrons fill the "holes," and there are no free holes or electrons. No holes means that there is no way for current to flow in this region. As the area where the two semiconductor types meet is depleted of charge carriers, *i.e.* there are no holes or electrons, it is called the depletion region.

Even though the depletion region at the junction is very thin, often only a few thousandths of a millimeter, current cannot flow in the normal way. Different effects are noticed depending upon the way in which the DC voltage is applied to the junction. If a voltage is applied (as shown in Fig. 2A) such that the P-type area becomes positive and the N-type becomes negative (forward bias), holes are attracted towards the negative voltage and are forced to jump across the depletion layer. Similarly, electrons move towards the positive voltage and jump the depletion layer. Even though the holes and electrons are moving in opposite directions, they carry opposite charges and as a result they represent a high current flow in the same direction.

If the voltage is applied to the PN junction (as shown in Fig. 2B) in the opposite sense, very little current flows. The reason for this is that the holes are attracted towards the negative potential, which is applied to the P-type region. Similarly the electrons are attracted towards the positive potential, which is applied to the N-type region. In other words the holes and electrons are attracted away from the junction itself, the depletion region increases in width and forms a potential barrier.

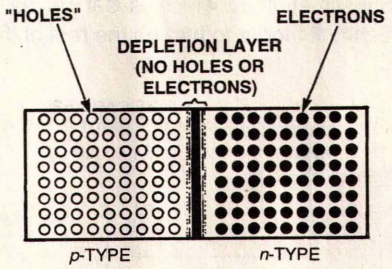


Fig. 1. A PN junction with no voltage applied.

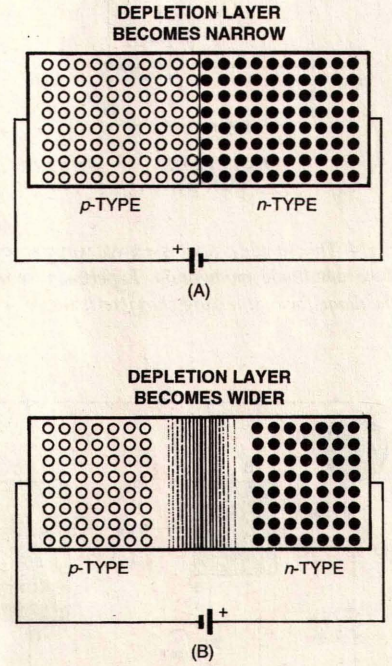


Fig. 2. When a positive voltage is applied (forward bias), as shown in (A), the depletion region becomes narrow and a high forward current flows; when this voltage is reversed (reverse bias), as in (B), the depletion layer becomes wider and very little current flows.

Not Ideal Characteristics

The PN junction is not an ideal rectifier having infinite resistance in the reverse direction and no resistance in the forward direction. Instead it has a characteristic like that shown in Fig. 3. From the diagram you'll see that a small amount of current flows in the reverse direction. It has been exaggerated to show it on the diagram, and in normal circumstances it's very much smaller than the forward current. Typically it may be picoamps (pA) or microamps (μA) at the most. However, it's worst at higher temperatures and it's also found that germanium is not as good as silicon. For example, a standard 1N4001 silicon rectifier has an average forward current rating of 1A (I_F) and a reverse current of 30 μA (I_R).

The reverse current results from what are called minority carriers. They are a very small number of electrons found in a P-type region or holes in a N-type region. Nowadays though, the manufacture of semiconductor materials is very much better and the number of minority carriers is much reduced, as are the levels of reverse currents.

Junction Barrier Voltage

In the forward direction it can be seen from Fig. 3 that very little current flows until a certain voltage has been reached. This represents the work that is required to enable the charge carriers to cross the depletion layer. The junction barrier voltage varies from one type of semiconductor to another. For germanium it is around 0.2 or 0.3 volts and for silicon it is about 0.6 volts.

In fact, it is possible to measure a voltage of about 0.6V across most small current diodes when they are forward biased. Power rectifier diodes normally have a larger voltage across them

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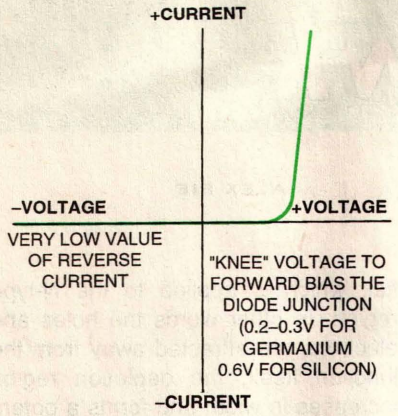
+CURRENT
–VOLTAGE
+VOLTAGE
VERY LOW VALUE OF REVERSE CURRENT
"KNEE" VOLTAGE TO FORWARD BIAS THE DIODE JUNCTION (0.2–0.3V FOR GERMANIUM 0.6V FOR SILICON)
–CURRENT

Fig. 3. Voltage-current characteristics of a typical diode.

but this is partly due to the fact that there is some resistance in the silicon, and partly due to the fact that higher currents are flowing and they are operating further up the curve (as shown in Fig. 3).

The PN junction is widely used as a rectifier in a number of applications, but it also has a number of other uses. In the coming months, we will be taking a look at some of these uses before moving on to some other interesting devices. But right now let's get to our readers' circuits. We have different circuits for different folks—in short, something for everyone!

LOW-DISTORTION, LOW-LEVEL AMPLITUDE MODULATOR

This simple diode modulator delivers excellent results when used for high percentage amplitude modulation (AM) at low signal levels. The parts shown in Fig. 4 are designed for an RF carrier input of 10 MHz. With a different tank circuit (L1/C1), this modulator will give excellent results at any frequency below 100 MHz (limited to the characteristics of D1). I used the *Hewlett Packard* 5082-2800 Schottky barrier diode; however, a standard fast silicon diode, such as the 1N4148 (equivalent NTE519), could also be used. A shunt resistor placed across the tank circuit reduces the "Q" of the circuit. This would permit a high percentage modulation without appreciable distortion.

—Alex Belenky, Brooklyn, NY

Simple but interesting circuit, Alex. By the way, the relationship between the variable capacitor and inductor determines the resonant frequency of the tank circuit ($f = 1/\sqrt{2\pi L1C1}$).

"PESKY CRICKET" CIRCUIT

The cricket is well-known for the chirping sound made by the males. They make their distinctive sound by rubbing an up-turned scraper on one forewing against a row of 50–250 teeth on the bottom of another forewing, producing a triple-modulated sound in the 1500–10,000-Hz frequency range. The circuit shown in Fig. 5 produces a pretty authentic triple-modulated cricket-chirp, but like a real cricket prefers to oscillate only in the dark. As you can imagine, this circuit makes an excellent practical joke, as your victim discovers a cricket in a room and will stop at nothing to locate and silence the little pest.

In operation, the cadium sulfide (CdS) photoresistor monitors the light level, and then outputs a voltage to the 555 timer, IC1, which is set up as a Schmidt trigger to turn on the rest of the circuit if it is dark and to turn it off under lighted conditions. Timer IC2 is an astable multivibrator, adjusted for 1.8 Hz. It modulates IC3, another 555, also configured astable operation and running at 50 Hz. The modulated output of IC3 powers an ordinary piezo-buzzer, which typically has an operating frequency in the 2–3 kHz range, just right for a fairly large cricket! Feed your cricket with a 9-volt battery.

When completed, just place the circuit in a hidden but not too dark spot in a room, and wait for your victim to ask for a flashlight and bug spray! To optimize the circuit for stealthy pranks, choose the smallest possible CdS photo cell and piezo-buzzer, and use surface-mount components, so the board is the same size as the 9-volt battery. Care to make this circuit more authentic? Replace the 100k resistor of IC2 with a thermistor in the 100k range, and you now have a "thermometer cricket," whose chirp rate is proportional to the ambient temperature!

-Nick Cinquino, Schaumburg, IL

I can see lots of fun with this neat circuit, Nick. To make the circuit even smaller, what about using a 556 dual timer or even a 558 quad timer? However, if the configuration gets too authentic you better watch out that you don't attract all the female crickets in the neighborhood!

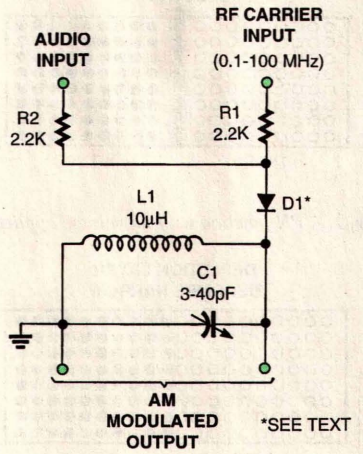

Fig. 4. This simple circuit is a great way to produce amplitude modulation. Experiment with the diode for best mixing characteristics.

SIMPLE AUDIO TONE-CONTROL CIRCUIT

A better alternative to all the tone-control circuits I have seen in recent years is the *Signetics* TDA1524 IC. This chip is supplied in a conventional 18-pin package and requires only a handful of support components. The circuit shown

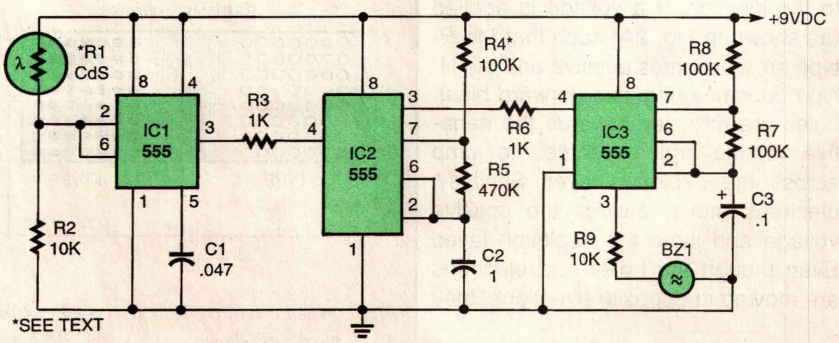

Fig. 5. This fun circuit simulates the chirp of a cricket—complete with a photo cell, which shuts down the circuit when a light shines on the "cricket!"

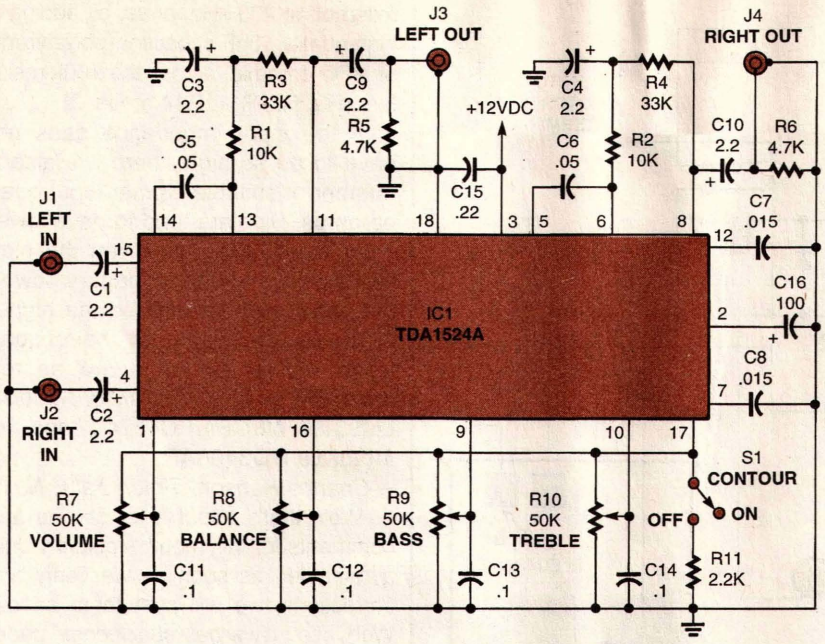

Fig. 6. This simple circuit uses the TDA1524 stereo audio control system IC as the only active component in this great amplifier add-on.

in Fig. 6 shows the TDA1524 in a typical design configuration that provides tone control for stereo inputs. The volume, bass, treble, and balance controls are single 50k linear potentiometers. A feature not found in other tone-control circuits is the loudness contour, which can be switched on or off, depending upon your audio requirements. With a 12-volt DC supply, volume control at maximum, and bass and treble controls centered, an audio input signal of 120 mV will produce a 1.5-volt output. The bass and treble controls allow about 14-dB boost or drop at 100 and 10 kHz, respectively.

I constructed the circuit on a small PC board to keep everything neat and compact. All the input/output jacks were RCA-type panel mounts. Since I wanted a stand-alone unit, the board was installed in a metal cabinet along with a small DC supply. This TDA1524 circuit makes an excellent companion to the TDA1554 power amp described in the February 1997 *Think Tank* column.

Robert O. Barg, Rochester, NY

Thanks for this neat circuit, Robert. I am sure that all those audiophiles will want to use this circuit in their stereo system. By the way, Robert indicated that he was able to pick up the TDA1524 IC from DC Electronics for $5.95, Tel. 800-467-7736. The cross-reference to this IC is the SK9884 (stereo audio control system).

AUTOMATED MOTOR PUMP SWITCH

I designed a circuit to automatically fill a watering tank to the right level. I do not have a tank, but I tested the circuit using a pail with water, and it works just fine. As you can see from Fig. 7, the circuit is designed around a 2N5060 SCR and a few other components. The secondary of the step-down transformer, T1, is rated at 12-volts, 500-mA minimum and the rectifier assembly, BR1, can be a modular type or derived from 1N4001 diodes.

When switch S1 is closed, if the water is below the level of the lower electrodes, there is no conduction through these electrodes. Since AC line voltage is applied to the pump terminals through the normally closed relay contacts, the motor pump is turned on to start filling the tank with water. When the level reaches the lower electrodes, conduction begins, and the anode of the SCR connects to the positive supply. The SCR is now in its standby mode. When the water level finally reaches the upper electrodes, a new conduction path through these electrodes is formed. The trigger pin of the SCR is now connected to a positive voltage, and the SCR is triggered. At the same instant, relay RY1 is energized, and its contacts pull in, disconnecting one line of the motor pump from the AC potential. The motor pump is therefore turned off, which stops the water flow. The LED now turns on, indicating that there is plenty of water in the tank. Should the water level fall below the upper electrodes, LED1 and relay RY1 remain latched on by the SCR. When water falls below the lower electrodes, the relay de-energizes and the LED indicator turns off. The water pump is turned on again to repeat this cycle.

Reset switch S2 is used if a blackout occurs. When the electricity comes back, the pump turns on if the water level is between the lower and upper electrodes. To stop the pump, just press S2 to turn it off and activate the LED indicator. Before you go on a vacation, open switch S1, which isolates the circuit from the 117-volt AC line. Switch S3 is for a lamp installed near the motor pump to provide light for repairs.

You can place switches S1, S2, and S3 on the project enclosure, so it will be easier to use them. For the electrodes, use 4-× 4-inch PCBs or plain aluminum stock. You can install the lower electrodes, say, 1-foot from the bottom of the tank. That way you still have some water when the LED indicates an empty tank. Secure each pair of electrodes close to each other for best conduction. All the circuit parts are available at RadioShack.

—Jose Ignatius A. Alea, Cebu, Philippines

The lamp is a nice touch. I would connect S3 to the other side of S1 instead. That way you can deactivate the circuit (by switching off S1) for safety, but still use the lamp.

MAILBAG, ETC.

Here's some corrections, suggestions, *etc.* to recent *Think Tank* circuits.

In the January 1998 Think Tank, page 68, Fig. 2, the component for "D1" is a 1N5464B (equivalent NTE612) or MV2107 (equivalent NTE, SK3326) variable capacitance diode (varactor). The 1N4817 (a standard recovery rectifier diode) shown in the circuit is incorrect.—Editor

I think there is an error in Alex Belnky's, "Twenty-Watt Audio Amplifier" circuit in the July 1997, *Think Tank*, page 65. In Fig. 2, a short is shown from the top of C1 to the R2, D1 junction, which essentially shorts out R2—does it belong there? Also would a 2N3904 transistor, or 2N2222, substitute for the

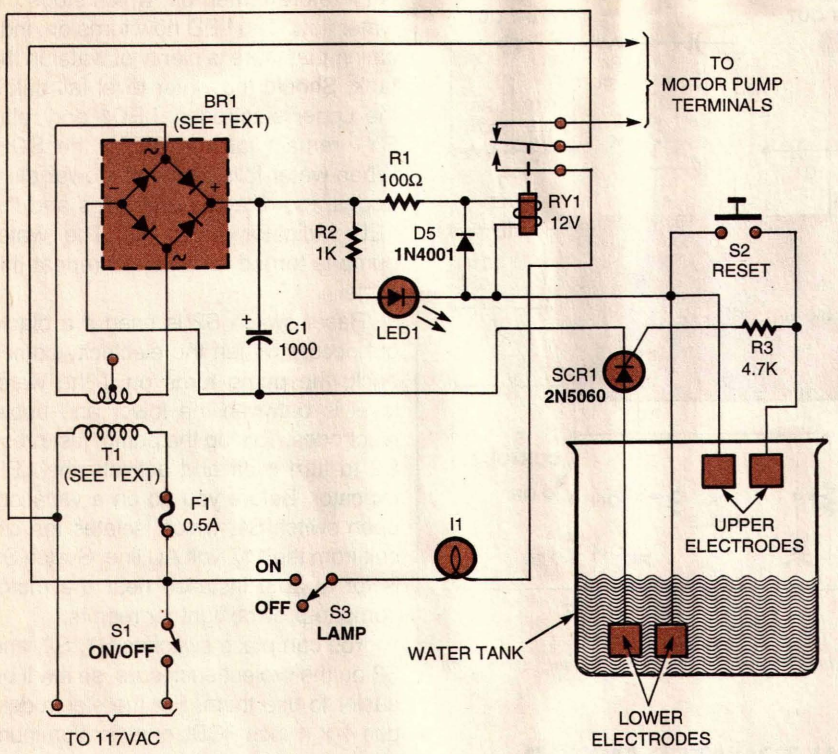

Fig. 7. Here's a useful circuit around the homestead that will always ensure a full water tank. It takes a little skill to set up and adjust those electrodes. Equivalent electrical parts for the circuit are RadioShack 276-1067 for SCR1 and RS 276-1101 for the 1N4001s. You can always use their modular rectifier unit, such as the RS 276-1146, to save some space.

2N5961? Finally, are the internal diodes in the SE9401 Darlington transistors something special, or could 1N4002 diodes be used if different Darlingtons (without internal diodes) were substituted?

—Dennis Share, Plainview, NY

Here are the responses we received from Alex: About that short, it should be removed, sorry! As far as the substitute for the 2N5961, I believe the 2N3904 would be a better choice—but I never tried it. Lastly, I believe the internal diodes of the SE9401 Darlington are especially made for this transistor (temperature-compensated, etc.). But like I said for the transistor substitution, it would not hurt if you experimented with other parts, just make sure they can handle the requirements of the amplifier.
via e-mail (http://idt.net/~alexbel)

In the September 1997 *Think Tank*, page 74, a question arose as to a quad-package equivalent to the *National Semiconductor* LF353 dual JFET op-amp used in the "Four-Channel Audio Mixer" circuit (Fig.2). There are actually a few good quad op-amps for audio available. The oldest is the *Texas Instrument* TL074. The problem with the FET input LF353 and the TL074 is the propensity for latch-up and/or input inversion when the input signal exceeds the power supply rails. This is a possibility when the power supply is only ±9-volts DC. For this reason, it is a good idea to clamp the inputs to the power supply rails with 1N4148 diodes. *National* also makes two JFET quads, designed about the same time as their LF353, which are also suitable—the LF347N and the LF444CAN.

There are newer BiFET devices, which can withstand input peaks greater than their supply voltages and are suitable for high-quality audio use. The *Analog Devices* AD713KN (available from *Jameco*, Tel. 800-831-4242) and the *Linear Technology* LT1058CN (available from *Digi-Key*, Tel. 800-344-4539) are two I have used with great success. They have the added advantage in that the input offset voltage is less than 1 mV, so you can direct couple the signals after the input stage and save quite a few film capacitors. For stability reasons, the four input stages should have their high-frequency gains rolled off at 200 kHz, or so, by adding a high quality 10pF capacitor (polystyrene or NPO ceramic) across the 100k resistors (R3, R7, R11, R14 of Fig. 2).

If the input impedance does not have to be so high, there are also a number of suitable bipolar input quad op-amps. Bipolars tend to have lower input noise, although given the high resistances needed for battery power, the resistor noise may be the higher noise source. Some of these quad audio bipolar op-amps are as follows: *PMI(ADC)* OP-471GP, *National* LM837N, *NECE* µPC4574C, and the *Motorola* MC3408AP.

—Charles Hanson, Tinton Falls, NJ

Well, that's about it for circuits and comments for this month's column. Just a reminder, as soon as we verify any corrections, we will post them on our Web site: *www.gernsback.com*, under the **Popular Electronics**, Forum link. Remember—this is **your** column—keep those circuits and ideas coming in.

Write me—Alex Bie, *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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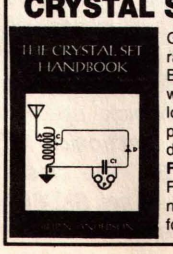

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SCANNER SCENE

Base Station Trunking Scanner

MARC SAXON

You said you wanted a base station scanner that could wrestle with UHF trunked systems. You've got it! It's *Uniden's Bearcat BC-895XLT Trunk Tracker*, and it's brimming over with features.

There are 300 memory channels in ten banks. The unit covers from 29 to 512 MHz and 806 to 956 MHz (minus the cellular bands, which are permanently factory-blocked as per FCC edict). The BC-895XLT normally searches and scans at nearly 100 channels per second, but can zip through them at an incredible 300 channels per second when placed in Turbo mode.

The unit gives instant one-button access to scanning all NOAA weather channels, and it provides a severe weather alert warning tone. There are service search access buttons for aeronautical, police and fire/emergency services. Users can select ten priority channels, as well as program 20 skip channels for service search scan, plus another 20 for regular search scan. The BC-895XLT allows manual channel access, directly to any specific desired frequency. It provides the option of stepping through the channels or using the rotary tuning control.

The Uniden BC-895XLT scans regular VHF/UHF communications, plus it can also efficiently track Motorola 800 MHz trunked systems. It is not designed to track 400 MHz bond trunked systems, nor GE trunked systems. It can search for all channels used in trunked systems, tracking those using as many as 50 channels. You get to hear both sides of trunked system conversations, even if the trunking frequencies change between replies.

How about a signal strength meter? And a built-in CTCSS (PL tone) board that lets you read the tones that may be in use on the channel being monitored. There's an RS232C port to allow computer control of this scanner, using readily available software/hardware.

The Bearcat BC-895XLT is a good-looking top-grade scanner for the serious user. It's available from Uniden Bearcat dealers nationwide.

Uniden's new Bearcat BC-895XLT Trunk Tracker base station scanner continuously covers 29 through 512 MHz and 806 to 956 MHz.

SCANNER FAMILY TREES

Some scanners look identical from the outside, such as the RadioShack PRO-2005 and PRO-2006, even though they aren't quite the same internally. Others vastly differ physically or mechanically from one another, but may practically be clones from an electronics point of view. Did you know that? This amusing but confusing aspect of scanner technology has vexed members of the hobby for a while, so we thought it might be of interest to pass along some of the family secrets of scanners.

There are major external but only minor internal differences between the PRO-2004 and PRO-2005, yet a few small changes were made to make the PRO-2006 slightly different from its (externally) identical twin, the PRO-2005. The handheld PRO-43 is a close relative of these scanners, but the later identical base station scanners, PRO-2035 and PRO-2042, are even closer in their circuitry to the PRO-2004/5/6 series.

The RadioShack PRO-26 is essentially the same internally as a Uniden Bearcat BC-3000XLT. Other nearly *identical twins* are the PRO-32 and the PRO-2021, the PRO-34 and the PRO-2022, the PRO-39 and the PRO-2032, and the PRO-64 and the PRO-2041. The PRO-62 is most likely a double of the PRO-2037, while the PRO-2035 matches up rather closely with the PRO-2042, with the exception of some CPU differences.

Uniden Bearcat's BC200XLT is the same as the BC-205XLT and the Regency R-4030. Their BC590XLT is identical to the BC-600XLT. Uniden Bearcat's BC-760XLT is a twin to their BC-950XLT and the Regency R-1600.

This information may be useful when evaluating or modifying scanners.

MAILBAG

A reader in New Jersey reports monitoring several DEA surveillance chopper pilots communicating with one another on 120.775 MHz, while directing ground surveillance vehicles on 418.75 MHz. According to the authoritative *"Top Secret" Registry of U.S. Government Radio Frequencies, 8th Ed.* (CRB Research), 120.775 MHz is a standard DEA air surveillance channel. The book suggests you also try 120.375 MHz for similar traffic. CRB Research's address is P.O. Box 56, Commack, NY 11725. A free catalog is available. Their phone number is 516-543-9169, the e-mail address is crbbooks@aol.com, while their Web site has a URL of *www.crbbooks.com*.

Many readers who live in Florida, or plan on visiting there, write to ask if we can offer a basic listing of good frequencies to monitor during Space Shuttle launches. Here are some suggestions for the areas of Patrick AFB and Kennedy Space Center that are being reported as active and interesting: 126.65, 133.75, 139.05, 141.30, 143.45, 163.4875, 164.7, 173.025, 259.7, 284.0, 294.6, 344.6, and 372.2 MHz. Undoubtedly there are dozens of other frequencies in use locally during a launch, and you can easily find them by search-scanning. The orbiter uses 259.7 MHz.

Here are two scanner tricks from Pete Levine of Utah. Pete says that on a certain channel he monitors, he wishes that the scan delay function operated for a bit longer than only two seconds. He solved this by programming the desired channel into his scanner (with the delay on) in two different memory positions ten slots apart. This gives the scanner another shot at picking up the reply, if it's just beyond the heels of the first channel's two second delay limit.

Pete's second trick is even better.

(Continued on page 64)

DX LISTENING

Shortwave Newscasts

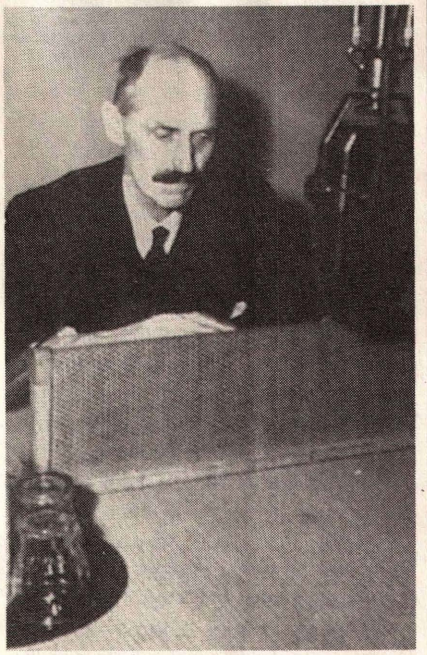
DON JENSEN

Beginning, I guess, back in the 1930s, news junkies have relied on shortwave radio to tell them what in the world is going on. Even the American radio networks would monitor SW broadcasts from foreign capitals to flesh out their own newscasts with the latest worldwide information. But technology has turned that old world upside-down. CNN and satellite links, "live-from-wherever" video, and the Internet have transformed the way we receive information. So, one might think, the old-fashioned shortwave news broadcast is as out-dated as great-granddad's buggy-whip. One might think that... but, apparently, one would be wrong!

Based on the mail received and contacts I have with SWLs here and overseas, listeners still have plenty of interest in tuning in SW news broadcasts from around the globe. Why, given the virtually instantaneous breaking news capabilities of, say, CNN, do listeners still tune to SW newscasts? Perhaps there are many answers, but a couple seem apparent.

First, there is viewpoint. TV may already be there with live pictures, but how is the big news event playing in Tokyo, in Teheran, in Jerusalem? For that perspective, it helps to listen in to a number of individual newscasts from different countries on shortwave to get a composite "big picture" view.

Secondly, shortwave can offer the "little picture" as well, covering news stories of purely regional or even local impact that global TV newscasts ignore or overlook. Political unrest in Papua New Guinea; stock market skid in South Africa; soccer cup results from Spain—these events may barely flicker the TV screen in the U.S. and Canada, but knowing about them can, perhaps, make us better informed about the world we live in.



Fifty years ago, Norwegian King Haakon VII spoke to listeners abroad, officially opening the shortwave service known today as Radio Norway International.

It is noteworthy that the respected shortwave annual, *Passport to World Band Radio* (or PWBR—and available from Universal Radio, 6830 Americana Pkwy., Reynoldsburg, OH 43068. Tel. 800-431-3939), includes several news broadcasts among its ten top shortwave programs of 1998. "World band radio is the nerve center for the world's news—real news from everywhere," the publication says. And one of the best is the British Broadcasting Corporation's World Service, "Newshour."

"No other broadcaster offers the same depth and breadth of coverage of what is happening in the world," PWBR says. "And amidst this wealth of riches, the jewel in the crown is 'Newshour,' 60 minutes of news and reports from around the globe. The choice of subjects is wide-ranging and includes national, regional, and international stories. Fast-breaking news is regularly updated throughout the program, with in-depth analysis of major topics being a regular feature. Not all is politics and crises—lighter stories also are offered, and there are business updates and news of major sporting events. There are two separate daily editions, at 1300 and 2000 UTC."

Those times, of course, are listed in UTC, or universal time, equivalent to Eastern Standard Time+5 hours, CST+6 hours, MST+7 hours, or PST+8 hours. Thus, 1300 and 2000 UTC are the same as 8 AM and 3 PM EST, 7 AM/2 PM CST, 6 AM/1 PM MST, or 5 AM/12 noon PST.

The BBC often changes SW frequencies with the season, but there are a number of channels in use at any given time, and finding one which offers decent signals is not too difficult. Some of the frequencies you may wish to try include 6195, 9410, 9515, 9590, 9740, 11865, 12095, 15220, 15575 and 17640 kHz at 1300 UTC. At 2000 UTC, check out the following—6180, 6195, 7325, 9410, 12095 and 15575 kHz.

REGIONAL COVERAGE

Also making the PWBR's top ten SW program list this year is "NewsLink" on Germany's international broadcaster, Deutsche Welle. It offers, the publication says, good regional—"that mid-ground between national and international reporting"—coverage of Europe.

"Deutsche Welle...has always leaned heavily toward coverage of European affairs, and its pioneering 'European Journal' has been a valuable source of continental news and analysis. Playing to this success in 1997, the station decided to merge its two main news programs—'European Journal' and 'Newsline Cologne'—into the new and more streamlined 'NewsLink.'"

"The result is a fast-moving 25-minute show with the accent squarely on Europe. Granted, important interna-

(Continued on page 64)

(CREDITS—Bran Boulden, CA; Bob Fraser, MA; Mark Humenyk, ONT; David Krause, OH; Harold Levison, PA; William McGuire, MD; Jim Moats, OH; Jay Novello, NC; Denis Pasqaule, PA; Ed Rausch, NJ; Jim Renfrew, NY; Chuck Rippel, VA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057).

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ANTIQUE RADIO

How Many Volts to Light a Tube?

MARC ELLIS

I was originally going to cover this topic in a full-length feature article to be published in a future issue of **Popular Electronics**. But since we've just finished a very long restoration project (*Freed Eisemann NR-5*), I'd like to talk about something other than nuts and bolts for now, and I'll bet most of you would agree. The time seems ripe for something more general, so let's go for it!

FILAMENTS VS. HEATERS

Before getting into the story, we'll take a minute to talk terminology. When an incandescent element directly supplies the electrons required to establish a plate current in a tube, it is called a *filament*. The original filaments were quite visible in the tube and very similar to the fiber or wire filaments Edison used in the first electric lamps—hence the name.

When the incandescent element in a tube is arranged to heat up a surrounding element, termed a *cathode,* which in turn becomes the electron source for the tube, it is called a *heater* (though it is still essentially a wire filament). The heater passes through channels inside the cylindrical cathode. It is usually out of sight except for a glowing section visible at the top.

Filamentary tubes were in common use during the battery-set era (most of the 1920s). Tubes with heaters and cathodes were introduced with the first AC ("plug-in") sets, which appeared in the late 1920s. I'll try to be conscientious about my language in referring to the "heating devices" for these two tube types.

Since we will be talking about a transitional era when battery and AC design practices were used in the same radio, and since this is a story about filament (or heater!!) voltages, I'll be discussing both types of tubes frequently, often in the same sentence. Now that you know this, you won't be surprised when I switch back and forth with dizzying frequency between the terms for the two different primary sources of electrons in a vacuum tube.

VOLTAGES AND MORE VOLTAGES!

The battery radios of the 1920s used tubes of various filament voltages, though generally all of the tubes in a specific set were the same type, or at least operated from the same voltage. Commonly used tubes were the 11 and 12 (1.1 volts), 99 and 120 (each 3.0–3.3 volts), and 01-A (5 volts). On the other hand, the early-1930s' battery sets intended for use on farms still not hooked up to rural electrification used tubes with 2.0-volt filaments, such as the types 30, 31, and 32.

Many of you may have noticed there seems to be an unusual and unnecessary variation in the filament or heater voltages required to light the tubes found in the early AC ("plug-in") sets—especially the first ones to come on the market in the late 1920s. To illustrate this point, I've included a detail from the schematic drawing of the power supply for the RCA Radiola 17, an AC receiver that appeared about 1927.

Notice that the power transformer has no less then *four* filament or heater windings. One lights the filament of the UX-280 rectifier tube. The other three power the filaments or heaters, respectively, of the UX-226, UY-227, and UX-171-A tubes used in the radio proper (we'll refer to these tubes by their more-modern, abbreviated designations: 80, 26, 27, and 71-A from here on out).

Notice also that the RCA draftsman has been conscientious in his use of the terms filament and heater in the labels for the windings. (The single type 27 in this radio is the only tube to have a cathode—and therefore a heater).

The type 80 filament, which operates from 5 volts, must be powered by a separate transformer winding to isolate the set's plate voltage from the rest of the circuitry. But why three windings to power the other tubes? It turns out that the three types used require different heater or filament voltages. The type 26 needs 1.5 volts; the type 27, 2.5 volts; the type 71-A, 5 volts. Most other AC sets of this era had a similar tube complement and required two or more transformer windings, in addition to the one for the rectifier for filament/heater power.

In more modern transformer-powered sets, say from the late 1930s, the power transformer typically had just two filament or heater windings: one for the rectifier tube (usually 5 volts) and the other for the remainder of the tubes in the radio (all operating from 6.3 volts). Other, non-transformer-powered, sets of the thirties and forties used tubes with heaters operating from much higher voltages, such as 12, 25, 35, or 50 volts.

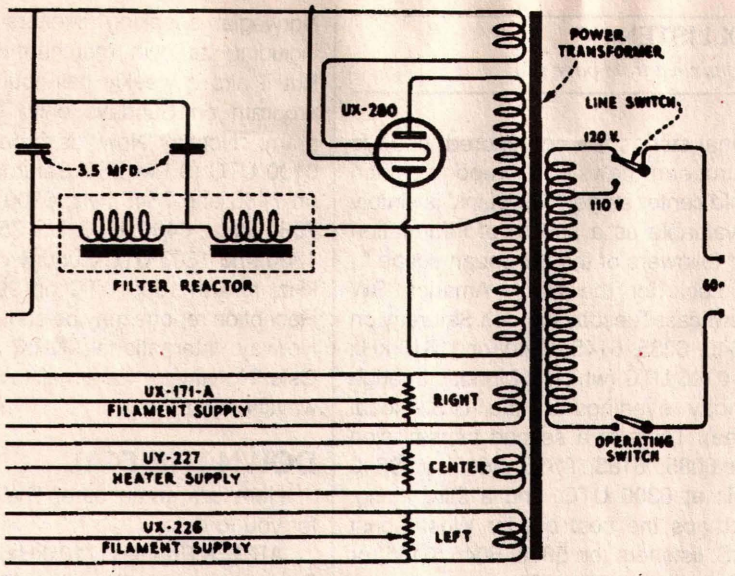
Why were so many different voltages chosen to light these tubes? Well some of the reasons have been lost in the mists of time. However, I think we can make quite a lot of sense out of what at first may seem to have been a whimsical and arbitrary selection process.

STORAGE BATTERY TUBES

We will start with the tubes for battery sets because the logic behind the voltages used to light their filaments is fairly apparent. In the days before radios could be powered from a wall plug, there were two main sources of power for radio tube filaments: (1) the rechargeable auto-style 6-volt storage battery or (2) the large No. 6 1.5-volt dry cells, sometimes called "ignition cells," commonly used to power doorbells in homes without electricity, magneto-phone sets in rural areas and, I suppose, ignition systems in primitive stationary gas engines.

The storage battery was heavy and clumsy, and contained corrosive acid that could ruin floors and carpets. It had to be lugged down to the corner gas station every once in a while for recharging (at least in the days before the trickle charger became a popular living-room accessory). Dry cells were much lighter and far less messy, but were probably more expensive to use because they were not rechargeable and had to be discarded when exhausted.

The storage battery was the filament power source of choice for larger sets,



Detail from schematic of RCA Radiola 17 power supply reveals that power transformer had no less than four (!) filament windings.

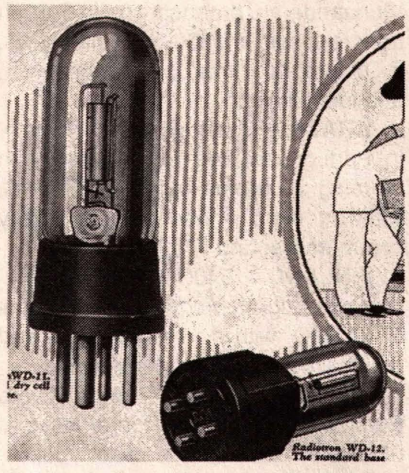


Illustration from 1925 ad for RCA Radiotrons shows type 11 (left) and 12 dry-cell tubes.

and the tube developed for storage battery use was the familiar 01-A with its 5-volt filament. Why 5 volts for a 6-volt battery? The reason is based on the fact that an auto-style storage battery can deliver usable power even when discharged to the point where it is delivering only five volts.

To get maximum usage between charges, radios were equipped with rheostats for cutting back the voltage of a new battery to this value. As battery voltage declined, the listener would cut more and more resistance out of the circuit to maintain the filament voltages at 5 volts. Once the voltage dipped below five, it was recharging time.

DRY BATTERY TUBES

The selection of filament voltages for dry-cell tubes followed a similar logic. Two voltage standards eventually emerged. The type 11 (and the identical, but differently based, type 12), intended for smaller sets, was designed to be operated from a single 1.5-volt dry cell. As such, it was designed to have a filament voltage of 1.1, leaving leeway for rheostat adjustment as battery voltage declined.

The type 99, which tended to be used with multi-tube sets, was designed to be used with three 1.5-volt dry cells in series—delivering 4.5 volts. Its filament was built for 3.0-volt operation (later upped to 3.3) to give plenty of "rheostat leeway."

Battery sets were quickly replaced with plug-in models when the technology became generally available in the late 1920s. However, they remained in use quite a bit longer on farms, many of which did not have access to commercial electricity until late in the 1930s. And so, for these farm sets, battery-radio technology had some time to evolve a little further.

For filament power, these "second generation" battery sets used a new dry battery developed by *Eveready*. The *air cell*, as it was called, was similar to the "ignition cell" we just discussed, except that its chemical processes required oxygen that was absorbed from the outside air via perforations in its case. The case was made of hard rubber, similar to that of a storage battery, but the air cell was not rechargeable and was discarded after exhaustion.

The air cell delivered two volts at its terminals, and this voltage remained essentially constant throughout its useful life. Power rating was 600 ampere-hours, which meant that a radio drawing 0.25 amperes could be operated for 2400 hours. The cost of a similar period of operation using No. 6 dry cells was about double. Of course, the special range of tubes developed for air cell use (types 30, 31 and 32) had two-volt filaments.

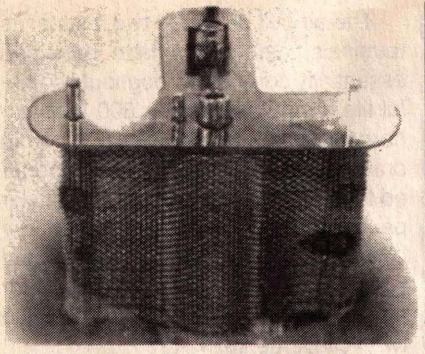
THOSE EARLY AC TUBES

In order to develop radios that would draw their power from the wall socket rather than from batteries, designers had to find ways to power tube filaments from alternating current. Most battery tubes, such as the heavily used 01-A, would introduce excessive hum into the received signal if operated from an AC source.

One exception was the type 71-A "power amplifier." This tube was designed towards the end of the 1920s to get more punchy sound from storage battery sets. It was intended to replace the 01-A used as a second audio amplifier, and so of course it had a 5-volt filament. The 71-A found little use for its intended purpose because battery sets were on the way out. However, it worked very well with AC on its filament in the non-critical second audio position, and so was pressed into service as the second audio tube in most of the early AC sets.

Another exception was the rectifier tube (almost always a type 80). Its job was simply to turn high-voltage AC into DC for the receiver plate supply, and it was no way part of the path traveled by the signal through the receiver. Thus it could have AC on its filament with no consequences. Its 5-volt rating was probably selected to match that of the type 13, which it replaced. And the 13's rating was probably selected by analogy with the type 01-A, which was certainly dominating the tube manufacturing industry in 1925 when the 13 was introduced.

The first tube especially designed to have an AC-powered filament was the type 26, developed as a replacement for the 01-A. In creating this first AC tube, designers found that they could minimize introduced hum by carefully balancing the current passing through the filament with the voltage across it. Their best results were obtained with



Close-up of type 27's innards. Top of cathode can be seen poking through plate-support structure.

1.5-volts at 1.5 amperes, and that is the rating of the filament that was put into the type 26. The 26 replaced the 01-A quite successfully as an RF and first AF amplifier, but it introduced too much hum when used in the highly critical detector stage. For that, a new tube design would be needed—one that would be even more efficient in suppressing AC hum than the type 26.

The result was the type 27, the first tube with a cathode—an innovation so successful that virtually all AC tubes from that time on would incorporate it. More on the type 27 and subsequent tube developments, next month.

In the meantime, we'd like to hear from *you*! While letters cannot be answered directly, your comments and questions are considered very seriously. Most are printed in this column for response by the readership at large. Write me at *Antique Radio*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

SCANNER SCENE

(continued from page 59)

Spread out with, say, a separation of 100 channels or more between two entries of the same frequency, it becomes almost the same as adding another priority channel, and less annoying than a regular priority channel inasmuch as it doesn't keep up that infernal "flashing." This way, you'll scan your desired frequency twice as often as normal. Fact is, you can do this fake priority channel trick with several frequencies you want to carefully watch. Are our readers clever, or what?

Our direct e-mail address here is Sigintt@aol.com, or you're invited to snail mail *Scanner Scene* in care of **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

DX LISTENING

(continued from page 60)

tional stories are not ignored, but it is European news and reports which hold center stage. 'NewsLink' is simply invaluable as a source of information for followers of the European scene."

Look for the North America SW newscast Tuesday through Saturday on 6040, 6085, 6145, 9640, or 11810 kHz at 0106 UTC (which is Monday through Friday evenings in the U.S.—local time). There is a second transmission on 6085, 6185, 9535, 9615, or 9640 kHz at 0306 UTC, and a third airing, perhaps the best bet for West Coast U.S. listeners, on 5960, 6045, 6185, or 9515 kHz at 0506 UTC.

Other SW stations broadcasting in English which tend to include more regional or national news include:

Voice of Greece, Athens, with about 10 minutes of news at 0130 UTC on frequencies which may include 6260, 7448, 9420, 9935, or 11645 kHz.

Albania's Radio Tirana, also with about 10 minutes of English news from this little-known Balkan country at 0145 UTC on 6115 and 7160 kHz.

R.A.E., Radio Argentina al Exterior, airing English news and short features on life in Argentina during its 0200 UTC hour on 11710 kHz.

Kol Israel, with 15 minutes of news in English from Israel Radio's domestic network at 0400 UTC on 7465, 9435, and 17545 kHz.

South Africa's Channel Africa focuses on news affecting and involving that continent. This station can be heard in English at 0500 UTC on 9675 and 11900 kHz.

HAPPY BIRTHDAY NRK

Radio Norway International celebrates its 50th birthday this year. It was on January 3, 1948, when the Norwegian monarch, King Haakon VII officially opened the international broadcasting station. Though Radio Norway International operates on a smaller scale than other European SW broadcasters, this Nordic nation has invested in some high-powered transmitting equipment necessary to provide solid signals to listeners around the world. Programs are broadcast via transmitters based in Sveio, and Kvitsøy, on Norway's west coast.

Its broadcasts are aimed mostly at Norwegian-speaking listeners abroad, including its own merchant seamen. But it airs a weekly half-hour English program on Sundays only. The program, "Norway Now," is broadcast at 0100 UTC (9 PM EST Saturday night) on 7465 and 7545 kHz; 0200 UTC on 7565 kHz; 0400 UTC on 7520 kHz; 1300 and 1600 UTC Sunday on 13805 kHz, and at 1900 UTC on 9960 kHz. Reception reports may be sent to Radio Norway International, NRK, N-0340, Oslo, Norway; or via e-mail to radionorway@nrk.no.

DOWN THE DIAL

Here are some other SW stations for you to tune:

ARGENTINA—11710 kHz, RAE in Buenos Aires has English at 0205 UTC. This station has been heard advising listeners how to send for a QSL card.

BELGIUM—9925 kHz, Radio Vlanaanderan, broadcasting in English from Brussels at 2330 UTC, has news, a DX program, mailbag, commentary, and identification.

BRAZIL—11805 kHz, Radio Globo, in Portuguese, has been heard with morning programming at 1105 UTC, with an echo announcement, many commercials, and IDs.

FINLAND—15400 kHz, Radio Finland has English programming at about 1240 UTC, with a weather report and regional news and an identification.

HUNGARY—6120 kHz, Radio Budapest has English programming at 0100 UTC, including a station identification and newscast.

PERU—9675 kHz, Radio del Pacifico in Lima can be heard here with all Spanish programming from 1600 UTC, with a local listener phone-in program, identification, frequency, and a string of commercials.

SAUDI ARABIA—11870 kHz, the Broadcasting Station of the Kingdom of Saudi Arabia is noted here with its 500-kilowatt transmitter. Programming, beginning at about 0300 UTC, is in Arabic.

SLOVAKIA—5930 kHz, Radio Slovakia International can be heard on this frequency after 0100 UTC, with identification and frequencies, then news in English.

SOLOMON ISLANDS—5020 kHz, Solomon Islands Broadcasting Corp. has been noted with fair signals, featuring island music and talk, at about 1045 UTC. ■

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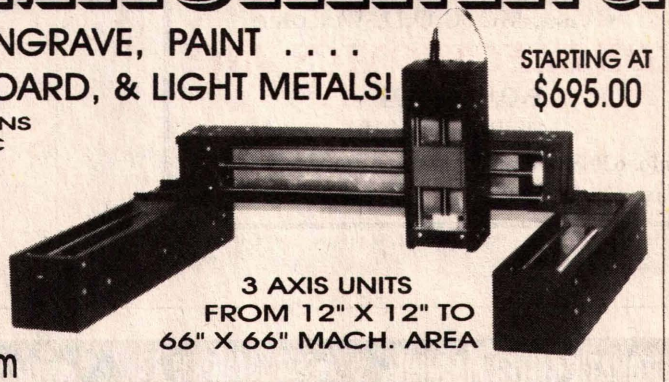

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Touch-Tone Input - Decodes DTMF tones used to dial telephones and sends them to your serial port. Keep a log of all outgoing calls. Use with the Caller ID kit for a complete in/out logging system. Send commands to the Home Automation or Digital I/O kits using a remote telephone. **$33.50**

Telephone Call Restrictors

Two modes of operation; either prevent receiving or placing telephone calls (or call prefixes) which have been entered into memory, or prevent those calls (or call prefixes) which have *not* been entered.

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Block out selected incoming calls. Calls identified using Caller ID data. **$46.00**

Phone Line Transponder

7 individual output pins are controlled with buttons 1-7 on your touch-tone phone. Automatically answers telephone and waits for commands. Monitor room noises with built in mic. *Dial-Out* pin instructs unit to pick up phone and dial user entered number(s). Password protected. **$49.00**

IR Remote Control Receiver

Learns and records the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. 7 individual output pins can be assigned to any button on your remote, and can be configured for either *toggle* or *momentary* action. **$32.00**

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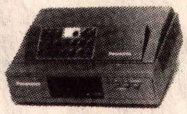

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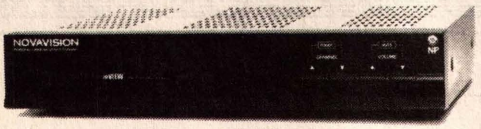

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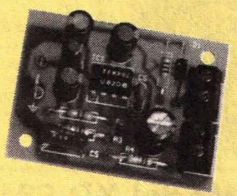

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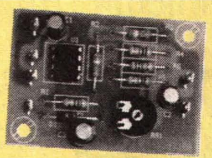

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May be used any amplifier with line level input. Gain is adjustable via board mounted potentiometer. Input level 560ohm, 5mV. Output level 1Kohm, 300mV. Operates with supply voltage from 6~18VDC, 5mA. Board dimensions 50mm x 35mm x 20mm.

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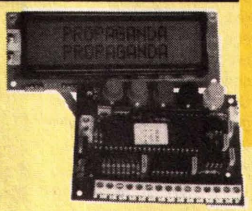

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One or two line x 16 character display is fully programmable and stores up to 14 alpha numeric messages. Backlit display allows viewing in any light. Messages can be individually displayed by closing specific contacts on terminal strip mounted to the board. Programming is easily done via a menu programming, similar to that of VCR or camcorder text. Data can be sent between multiple units to allow fast programming of a many units. Requires 12VDC, 300mA.

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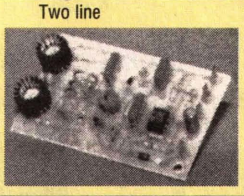

High Power FM Transmitter

Accepts line level input (300mV), and transmits audio to any standard FM radio. Output frequency can be adjusted anywhere in the 88~108MHz FM band. Requires 9~15VDC supply, 150mA. Board dimensions 50mm x 65mm x 20mm.

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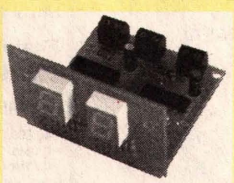
Two Digit LED Counter



Provides digital count from 0 to 99. Contact closure input provides one count up and reset-to-zero function. Each digit is 0.5" high. Requires 12VDC, 100mA. Dimensions 70mm x 52mm x 46mm.

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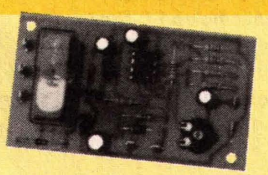
Call for information on many other types of pre-assembled modules including timers, counters, temperature controls, VOX relays, Programmable LCD displays and power supplies.



Voice Activation (VOX) Relay

5A output relay is energized when audio signal level is detected. Input level 50mV, 10Kohm. Sensitivity is adjusted via a board mounted potentiometer. Requires 12VDC, 50mA. Board dimensions 75mm x 40mm x 30mm.

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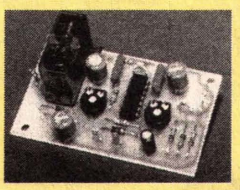

On Delay Timer Module

Provides precision time delay for a variety of uses. Upon contact closure, the output relay remains open, until a predetermined amount of time passes, then closes. The relay remains closed for a predetermined amount of time, then opens again. Both predetermined times are independently adjustable by two board mounted potentiometers. Relay contacts 5A. Requires 12VDC, 500mA. Board dimensions 43mm x 75mm x 30mm.

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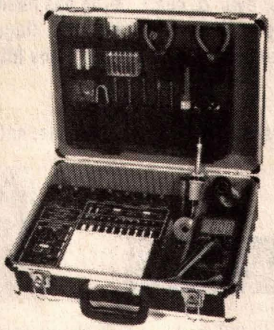

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Electrician's, maintenance, service, and safety personel can quickly test for energized circuits and defective grounds on the factory floor, in the shop, or at home.

- Fits in shirt pocket for convenience.
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Detects voltage metallic contact.

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Model LCR-1810

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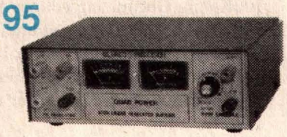

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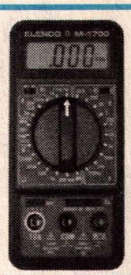

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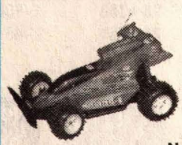

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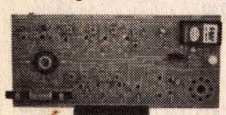

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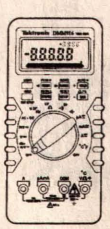
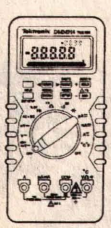


DMM 912 $189



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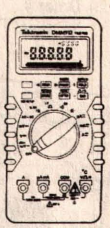

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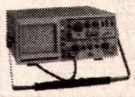

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- Sweeps to 5ns/division
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- Signal delay line
- V mode-displays two signals unrelated in frequency.
- Component tester

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- Z-axis input
- Single Sweep
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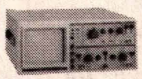

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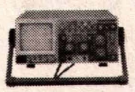
- V-mode - displays 2 signals unrelated in frequency.
- Component tester
- Z-axis input
- Single sweep



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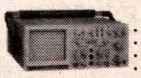
- AC, TVH, TVV and line coupling
- Calibrated 19 step time-base with x10 magnifier
- Compact low-profile design



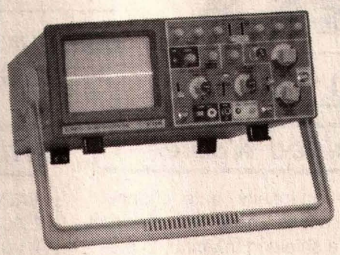
Affordable Spectrum Analyzers by B&K

500MHz Series
Model 2615 - $1595
Model 2620 w/ tracking generator - $1895

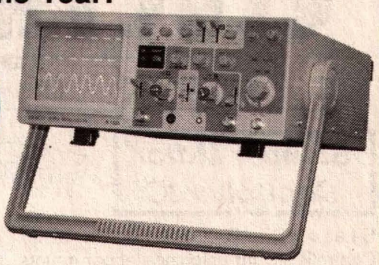
1.05GHz Series
Model 2625 - $2395
Model 2630 w/ tracking generator - $2995

Quality Scopes by Elenco

Lowest Prices of the Year!



Includes Free Dust Cover and Probes



60MHz

DS-603 $1350
- Analog / Digital Storage
- 20MS/s Sampling Rate

S-1360 $749
- Analog with Delayed Sweep

100MHz

S-1390 $995
- Analog

40MHz

S-1345 $569
- Analog with Delayed Sweep

S-1340 $475
- Analog

2 Year Warranty

25/30MHz

DS-303 30MHz **$1095**

DS-203 20MHz **$725**
- Analog / Digital Storage

S-1330 $439
- 25MHz Analog
- Delayed Sweep

S-1325 $325
- 25MHz Analog

SIMM MODULE TESTER

B & K 898 **$625**
- Tests 72 and 30-pin SIMMs to 36 bits.
- Stand alone and portable. No other equipment required.
- Automatically identifies width, depth and speed of SIMMS.
- 10 built-in tests identify most memory defects. Preheat cycle prior to test.

PORTABLE SEMICONDUCTOR TESTER

B&K 510
- In or out-of-order circuit tests for transistor, FETs, SCRs and darlingtons.

$199.00

Fluke Multimeters

Model 70III	$85	Model 83	$235
Model 73III	$115	Model 85	$269
Model 75III	$139	Model 87	$289
Model 77III	$154	Model 863E	$475
Model 79III	$175	Model 867BE	$650

B&K Precision Multimeters

Model 391	$143	Model 388A	$99
Model 390	$127	Model 2707	$75
Model 389	$109	Model 2860A	$79
Model 5390	$295	Model 5370	$219
Model 5380	$265	Model 5360	$195

MX-9300

Four Functions in One Instrument

Features:
- One instrument with four test and measuring systems:
  - 1.3GHz Frequency Counter
  - 2MHz Sweep Function Generator
  - Digital Multimeter
  - Digital Triple Power Supply
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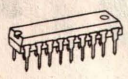
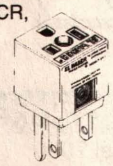
Stepper Motor Controller IC



E-Lab # EDE-1200
Controller IC for unipolar stepper motors. Designed to interface a logic-level signal to a stepper motor. Also capable of running independently (self-clocking). Allows for half-stepping and directional control. TTL/CMOS compatible inputs. TTL-level outputs. 18 pin DIP package. 5 vdc operation. Works for most unipolar stepper motors. Includes specs and hook-up diagram.
CAT# EDE-1200 $12.50 each

PRICE REDUCTION! SL WABER "PowerMaster" Surge/Noise Suppressor



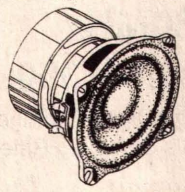
Protect your computer, phone, VCR, TV and stereo equipment from damaging transient voltage surges. Just plug in, and you've got full 3-line protection. Visual indicator lets you know that the device is functioning.
UL, CSA listed.
CAT # PW-103 $2.75 each
Formerly $3.75

S-VHS Tape (Used)

Super VHS tape users! Save a bundle on name-brand S-VHS, T-120 tapes. These tapes were used for a brief period, then bulk erased. The record-protect tabs have been broken out, so you will have to cover the notch with a piece of tape, but they work great and cost a fraction of the "new" price. Try some, you'll be back for more.
CAT #S-VHS $3.00 each
10 for $28.00 • 100 for $250.00

Shielded Woofer

Designed for use in Infinity center channel video sound systems. These well constructed woofers have shielded magnets to prevent interference with picture quality.
5 1/4" 6 OHM
1" voice coil. 8 oz. magnet. 50 watts max power. 3.125" deep.



CAT # SK-7346
$10.00 each
12 for $96.00

Miniature Temperature Sensor (THERMISTOR)

Keystone (Similar to #RL0503-17-56K-96-MS) 30K ohms @ 25 degree C. (77 degree F.) Negative temperature coefficient. 0.2" long X 0.09" diameter, epoxy insulated bead. 1.13" long teflon insulated AWG#30 wire leads. Prepped with 0.75" long metal tabs.
CAT# THR-19
2 for $1.50
box of 264 $150.48 (57¢ each)

3 Volt Lithium Coin Cell

Panasonic # BR2330-1GU
3 volt, 255 mAh coin cell. Lithium batteries have a very long shelf life and are great for memory back-up protection. 0.9" diameter x 0.12" thick. 0.7" between positive and negative pc leads.
CAT #LBAT-16
2 for $1.50
20 for $12.00
100 for $45.00
1K for $300.00

Ferrite Bead

TDK # HF70RH 16X28X9
1.1" x 0.63" od x 0.35" id.
CAT # FB-24 $1.00 each
10 for $8.50 - 100 for $70.00

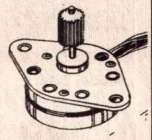
RED Ultrabright LED

PAINFULLY BRIGHT RED LED
2500 to 4000 mcd @ 20 ma. These T 1 3/4 (5 mm diameter) red LEDs are significantly brighter than conventional LEDs. At close range, they are painful to look at. They are great for attention getting displays that can be seen from a distance. Water clear in off-state.
CAT # LED-42
2 for $1.20
10 for $5.00
100 for $45.00
1000 for $400.00

High Brightness FLASHER LEDs

T 1 3/4 (5mm) high brightness RED LEDs with built-in flasher unit. 3-5 Vdc operation
CAT # LED-4 2 for 90¢
100 for $40.00 - 1000 for $300.00

Stepper Motor



Airpax # LB82246
Unipolar, two-phase, 6 lead stepper motor. 500 ohm coil. 7.5 degrees per step. 1.4" dia. X 0.7" body. Oval mounting flange has holes on 1.65" ctrs. 0.08" (2mm) dia. shaft is 0.4" long and is fitted with a 0.31" dia. gear with 18 teeth. 15" leads.
CAT # SMT-28 $2.00 each

"HI-8" Video Cassette

SONY Hi-8 Top quality, metal particle 120 minute video cassettes. *Used for a short time, then bulk-erased.* Each cassette has its own plastic storage box.
CAT # VCU-8
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General — **Rubber Boot Included**

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23 C 5 C RH<75%
Temperature Ranges:
Operating: 0 C to 40 C (32 F to 104 F)
Storage: -10 C to 50 C (14 F to 122 F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
*Dimensions:*188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	*Resolution:*	*Accuracy:*
200mV	100 V	
2000mV	1mV	(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	*Resolution:*	*Accuracy:*
200 A	100nA	
2000 A	1 A	(1.2%rdg+2dgts)
20mA	10 A	
200mA	100 A	(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	*Resolution:*	*Accuracy:*
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

AC Voltage (ACV)

Range:	*Resolution:*	*Accuracy:*
200V	100mV	(1.2%rdg+10dgts)
750V	1V	

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

20 AMP Switching Power Supply

$99.00 any qty

A very special Circuit Specialists offer. This 20 amp continuous switching power supply is available at this fantastic low price!

Specifications
Input Voltage: AC 110V +/- 15%, 50Hz/60Hz
Output Voltage: DC9V 15V variable
Polarity: Negative ground
Current (13.8v): 25A peak, 20A continuous
Overvoltage Protection
Cooling fan inside chassis

CAT NO	DESCRIPTION	PRICE
SPS-1020G	20 Amp Switching Power Supply	$99.00

Developer This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Etching Tank This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

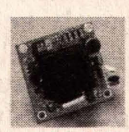
REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

1/3" CCD Board Cameras

Available with **PINHOLE LENS** with **AUDIO**; **STANDARD LENS** with **AUDIO**; and **STANDARD LENS** with **INFRA-RED**. These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras



WDP-2000

WDS-2005

WDI-4000

Specifications

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2_: 1 Interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED (no audio)	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00

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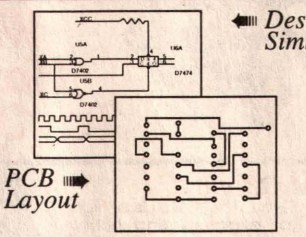

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- Analog simulator **(mentalSPICE)** for $199. Allows AC, DC and transient circuit analysis. Includes models of transistors, discretes, and op amps.
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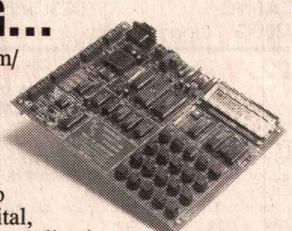

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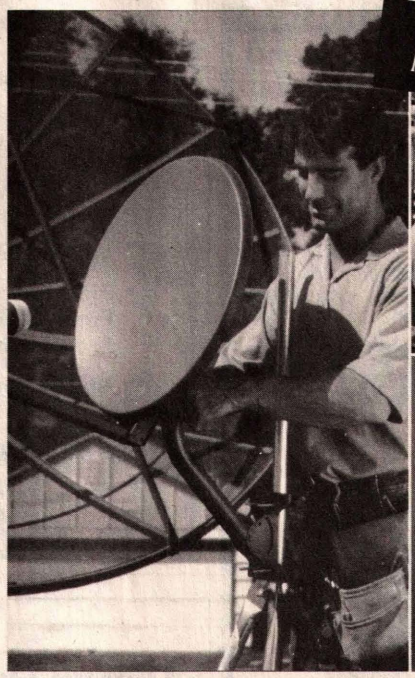

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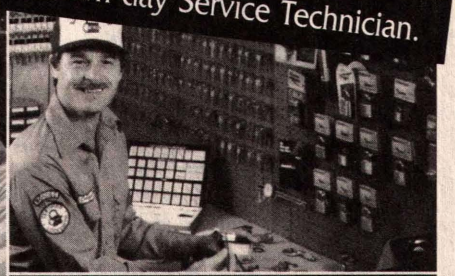

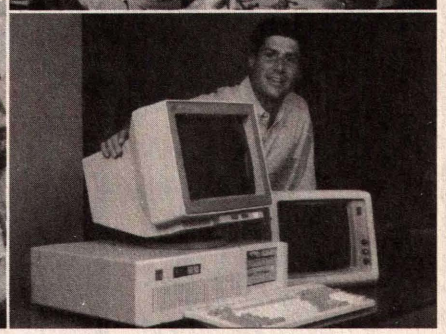

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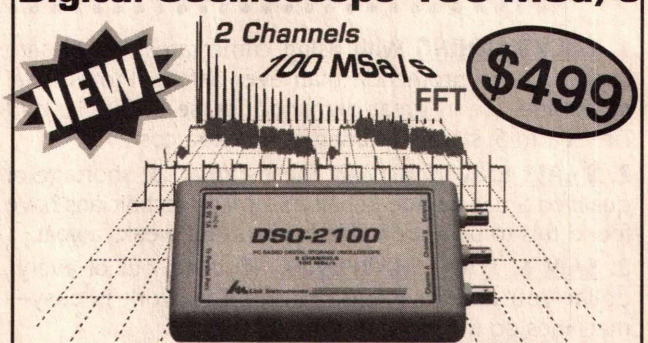

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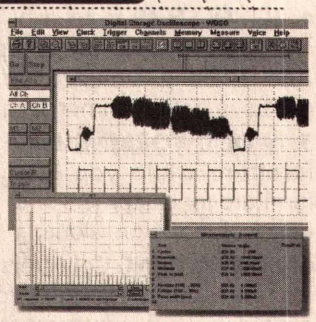

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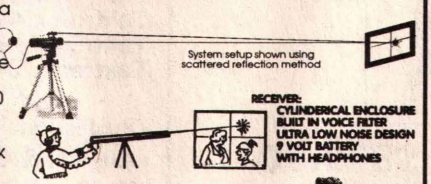

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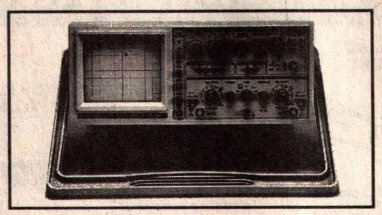

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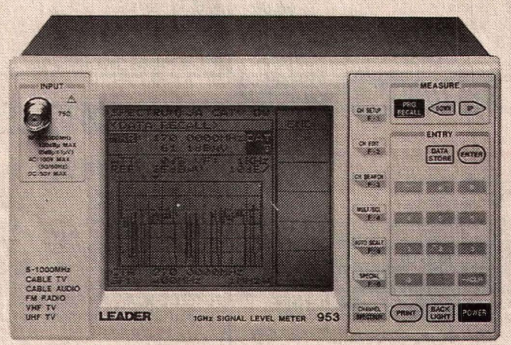

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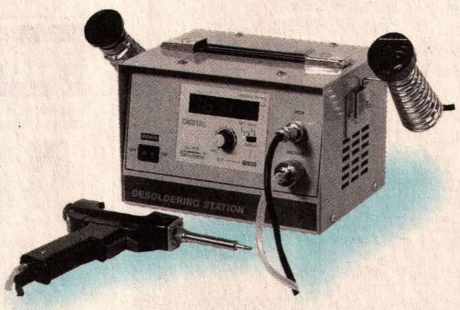

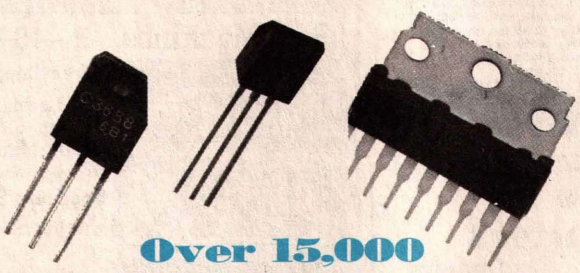

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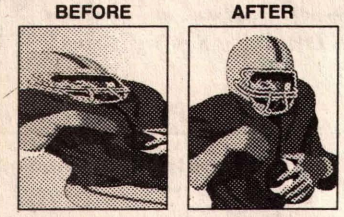

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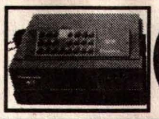

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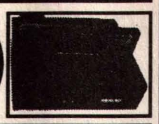

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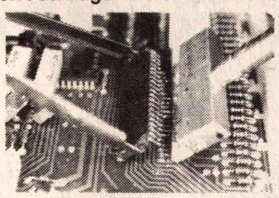

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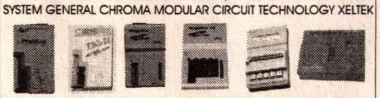

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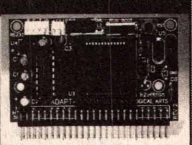

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Skyvision

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Ultra miniature hidden camera, in dome, smoke or motion detector w/ mic. B/W or Color. Wide view angle. Low light sensitivity + super sharp images, plus video and audio output. From $159.00. Also 1/3" B/W board Cameras w/mic. only $99.00 USD. Wireless hidden camera, start at only $249.00 USD. Plus $5.95 for S/H. Whole/Retail Welcome. COD, Check, Money Order or Visa/MC.

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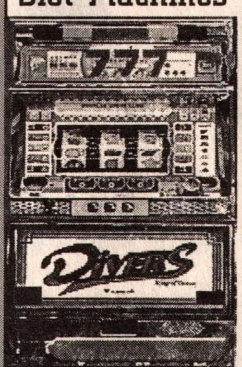
http://www.bolideamazingproducts.com

Slot Machines $ 449.00



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Slot Machine Demo Video $ 5.99
40 - Minutes
33" High 20" Wide 14" Deep
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- HIGH QUALITY TEST EQUIPMENT PROVIDER

15 Days Money Back Guarantee!

DMM

DMM-10 ($19.95): 3½ digit, DC/AC V, Ω, hFE, diode, signal output(+3V,-0.5Vsq.,50%duty)
DMM-17B ($39.95): 3½ digit,DC/ACV, contin., DC/ACA, Ω, Capacitance,hFE, diode, Freq
DMM-20 ($74.95): AC/DC (V, A), Freq, cont., Capac, Induct., Ω, hFE, diode, duty cycle
DMM-22 ($89.95): 4000counts, bar graph, Freq, AC/DC(V,A), Ω, Capacitance, diode, contin.
DMM-23T ($99.95): 4½ digit, high resol. (10uV, 10nA, 10mΩ), hFE, diode, contin., true rms
DMM-89S ($179.00): true rms, AC/DC (V,A), Ω, bar graph, freq, capac., dBm, logic, diode

DMM-113 ($24.95): Pocket Size, DC/ACV, Ω, diode, Continuity beeper
DMM-120 ($24.95): economy type, DCV,ACV, DCA, Ω,hFE, diode
DMM-122 ($59.95): DC/AC(V,A), Ω, hFE, diode, capacitance, freq, logic, continuity
DMM-123 ($44.95): DMM + capacitance, DC/AC(V,A), Ω, hFE, diode, continuity
DMM-124 ($69.95): Electrical+Temp,DC/ACV, , capacitance, freq, 3 phase, diode, contin.
DMM-125C ($54.95): Autorange + bar graph, DC/ACV, Cap,Ω, diode, continuity beeper

LCR METER

CAP-15 *($49.95)*: 3½ digit, 0.1pF-20mF, 9 Ranges, 0.1pF resolution zero adjustment.
LCR-195 *($89.95)*: 1uH-200H (induct.), 0.1pF-200uF(Capac.), 0.01Ω-20M Ω(resistance)
LCR-814 *($189.95)*: 0.1uH-200H, 0.1pF-20mF, 0.1Ω-20MΩ, Q Factor, dissipation, zero adjust
LCR-131D *($229.95)*: autorange, 0.1uH-10kH, 0.1pF-10mF, 1mΩ-10MΩ, Q Factor, serial/parallel, 120Hz/1kHz testing mode

FREQ. COUNTER

FC-1200 *($129.95)*: 1.25GHz Handheld, 8 digits display, 10ppm accurary, sensitivity 5mV (130-350MHz), 30mV (440MHz), 22m (800MHz), batteries or 9V adapter.
FC-2500 *($179.95)*: 2.5GHz Handheld, 8 digits display, 4ppm accurary, sensitivity <50mV, batteries or 9V adapter.
FC-5270A *($149.95)* 1.2 Ghz bench type, 8 digit, 10 ppm, 35mV sensitivity, 10Vp-p max. input, power by 9V adapter.
FC-5700 *($329.95)* 1.3GHz bench type, 8 digit, 1 ppm accuracy, 20mV sensitivity, period 0.1us to 100ms. Ideal for test & repair of audio instrument.

FLUKE DMM

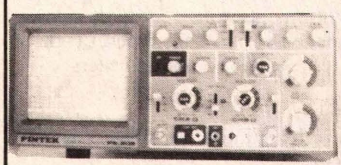
HandHeld		*Scope Meter*	
12	$ 84.95	**92B**	$1,399
70-II	$ 75.95	**96B**	$1,699
73-II	$ 97.95	**99B**	$1,999
75-II	$129.00	**105B**	$2,499
76-II	$175.00	**863E**	$469
77-II	$155.00	**867E**	$659
79/29-II	$175.00		
87	$287.00		

SPECIALTY

- Sound meter $169.95
- EMF Tester $69.95
- Conductivity $169.95
- Thermometer $69.95-$89.95
- Humid./Temp meter $169.95
- Press. meter $299.95
- Electr. scale $89.95
- Watt Meter $129.95
- High Voltgae Probe $59.95
- pH Meter $79.95
- Light Meter $80-$90
- Light Adapter $49.95
- Anemometer $179.95
- Anemometer adapter (And More) $89.95

OSCILLOSCOPE

Dual Trace, Component Test, 6" CRT, X-Y Operation, TV Sync, CH2 Output, Graticule Illum, 2 Probes(x1;x10)

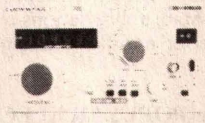


- PS-200 20 MHz Dual Trace $339.95
- PS-205 20 MHz Dual w/ Delay Sweep $429.95
- PS-400 40 MHz Dual Trace $494.95
- PS-405 40 MHz Dual w/ Delay Sweep $569.95
- PS-605 60 MHz Dual w/ Delay Sweep $769.95
- PS-1000 100MHz Dual Trace $999.95

Digital Scope:
- DS-303 30MHz Digital, 20 Samples/sec $849.95
- DS-303P RS-232 interface, 30Mhz $1,049.95

Scope Probe:
HP-9060 (60MHz) $15, HP-9150 (150MHz) $22, HP-9250 (250MHz)$29, HP-9258 (250MHz,100:1)$39

AUDIO/RF/FUNCT. GENERATOR

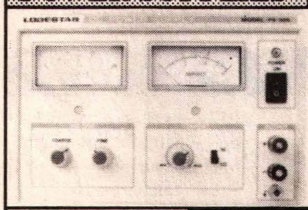


RF Generator
- **SG-4160** ($124.95) 100kHz-150MHz sinewaves in 8 ranges, 100mV at 35MHz
- **SG-4162** ($229.95): Generate same signal as SG-4160, but with int. counter (150MHz).

Audio Generator
- **AG-2601** ($124.95)10Hz-1MHz, 0-8Vpp sine, 0-10Vpp squarewave
- **AG-2603** ($229.95): Same as AG-2601, but with additional counter and digital display.

Function Generator
- **FG-2100A**($169.95).2Hz-2MHz,5mV-20$V_{pp}$
- **FG-2102AD** ($229.95) same as FG-2100A, but with int. counter and TTL, CMOS output.
- **FG-2103** ($329.95) *Sweep* 0.5Hz-5MHz, linear/log, VCG, GCV, and int. counter

POWER SUPPLIES



Single Output DC Power Supplies

- Short Circuit and overload protected
- Constant current, constant voltage mode
- 0.02%+2mV line regulation; 0.02%+2mV load regulate

Analog Meters Display
PS-303 ($159.00) 30V/3A
PS-305 ($219.95) 30V/5A
PS-8110 ($289.95) 60V/5A
PS-8112 ($399.95) 60V/5A
PS-1610 ($289.00) 16V/10A
PS-8107 ($399.95) 30V/10A

Digital Voltage, Analog Current
PS-8200 ($179.95) 30V/3A
PS-8201 ($239.95) 30V/5A

Digital Volt & Current Display
PS-8300 ($199.95) 30V/3A
PS-8301 ($259.95) 30V/5A

Dual Tracking

- Short Circuit & overload protected
- Constant current & constant mode
- Independent or Tracking

Dual Tracking (Analog V & I Displays)
PS-303D ($314.95) 30V/3A/30V/3A
PS-305D ($399.95) 30V/5A/30V/5A
PS-8108 ($549.95) 60V/3A/60V/3A
PS-8109 ($699.95) 60V/5A/60V/5A

Triple Output

- One fixed 5VDC, 3 Amp output
- Parallel to double current output (PS-8102 & PS-8103 only)

Triple Output (Analog displays)
PS-8102 ($399.95) 30V/3A/30V/3A
PS-8103 ($489.95) 30V/5A/30V/5A

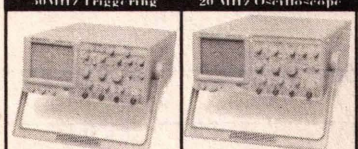
Digital Displays
PS-8202 ($499.95) 30V/3A/30V/3A
PS-8203 ($549.95) 30V/5A/30V/5A

INSTEK® Test & Measuring Instrument

ISO 9002 Cert. #934163 (2 Years Warranty)

OSCILLOSCOPE

OS-653 $699.95 — 50MHz Triggering
OS-622B $399.95 — 20 MHz Oscilloscope



- Dual CH / Delay sweep
- ALT trigger, trigger lock
- 1mV/div sen., delay line
- Zaxis input,CH1 output
- Hold off, TV syn.
- 2 probes (x1, x10)

- Dual CH/X-Y operation
- 1 mV/div sensitivity
- Z-axis input,CH1 output
- TV syn., trigger level lock
- 2 probes (x1, x10)

OS-305 ($209.95) - 5 MHz One Channel
OS-310 ($324.95) - 10 MHz One channel

DC POWER SUPPLIES

Triple Output

- 2 variable out 0-30V,0-3A
- One fixed 5V,3A output
- Auto track, serial, parallel
- Const. volt, current mode
- 4 analog or 2 digital display

PC-3030 ($499.95)
PC-3030D ($549.95)

Single Output

- Const voltage, current mod
- Voltage regulation <0.01%
- Current regulation <0.2%
- PS: 2 analog or 1 digital dis
- PR: 2 analog or 2 digital dis

Analog Meters Display
PS-1830 ($209.95) 18V/3A
PS-1850 ($219.95) 18V/5A
PS-3030 ($224.95) 30V/3A
PS-6010 ($209.95)60V/10A
PR-3060 ($314.95)30V/6A
PR-6030 ($314.95)60V/3A

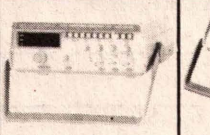
Digital Meters Display
PS-1830D($219.95)18V/3A
PS-1850D($244.95)18V/5A
PS-3030D($254.95)30V/3A
PR-6030D($399.95)60V/3A

Programmable

- High stability, low drift
- One fixed 5V,3A output
- 100point program(PPS ser)
- 50point program(PPT ser.)
- Auto serial/parall.(PPT ser)
- Auto track (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G ($1,099.95)
PPS-3635G ($1,099.95)
PPS-6020G ($1,099.95)
PPT-1830G ($1,399.95)
PPT-3615G ($1,399.95)

FUNCTION GENERATOR



FG-8015G($189.95)Sweep
- 0.02Hz-2Mhz,no counter
- Sine/Squ/Tri/pulse/Ramp

FG-8016G ($239.95)
- 0.02Hz-2MHz w/ counter
- Pulse, function generator

FG-8017G($249.95)Sweep
- Sine/Tri/Squ/TTL/CMOS
- 0.02Hz-2Mhz, FM mod.

FG-8019 ($399.95) Sweep
- 0.02Hz-2MHz w/counter
- INT/EXT AM/FM mod

FG-8019 ($209.95)
- 0.02Hz-2MHz w/counter

FG-8050 ($499.95) Sweep
- 0.05Hz-5MHz w/counter
- INT/EXT AM/FM mod

FG-830 ($1,499.95) 30MHz Synthesized Function Gen.
- Output: sine, tri., square, sync out, arb. waveform
- 20mHz Freq. resolution
- Linear/log sweep
- Arbitrary modulation
- RS232; IEEE-488(option)

BENCHTOP DMM

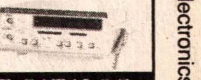
DM-8034($179.95) 3½ dgt
- AC/DV(V,A),C,Ω,diode
- 1000V, 20A, 0.5% accu.

DM-8040($339.95) 3½ dgt
- ACV to 50kHz, true rms

DM-8055($649.95) 5½ dgt
- 0.006% basic accuracy
- 1uV,1mΩ,1nA resolution
- dBm,auto,REL, min/max

DM-8055G($889.95)GPIB
- Same funct. as DM-8055

Frequency Counters
FC-8131 ($469.95)1.3GHz
FC-8270 ($629.95)2.7GHz
UC-2010G ($294.95)



Programmable Electronic Load (PEL-300)

(Patent Nos 81011/81324)

- Operating Rating: voltage 3-60V, current 6mA-60A, power 300W, temp 0-40C(operate)/-10-70C (store)
- Over voltage, over current, over power protection
- Operation mode: constant voltage, current, resistance
- Transient Gen. Frequency 1Hz-1kHz; duty 10-90%
- High Resolution: 20mV, 0.2mA, 0.3mΩ
- Self-Test and Software Calibration
- Meet UL CSA IEC Safety regulation

**** NEW *** ***$1409.95***

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CIRCLE 26 ON FREE INFORMATION CARD

USE POPULAR ELECTRONICS

READ BY BUYERS OF ELECTRONIC EQUIPMENT ACCESSORIES AND PARTS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but, in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $1.75 per word. Minimum charge is $26.25 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Sorry, no discounts on credit-card orders. Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $2.25 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. POPULAR ELECTRONICS is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in POPULAR ELECTRONICS is limited to electronics items only. All ads are subject to the publishers approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $1.75 per word, Minimum $26.25

Send you ad payments to:
POPULAR ELECTRONICS 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 – Antique Electronics
130 – Audio-Video Lasers
160 – Business Opportunities
190 – Cable TV
210 – CB-Scanners
270 – Computer Equipment Wanted
300 – Computer Hardware
330 – Computer Software
360 – Education
390 – FAX
450 – Ham Gear Wanted
480 – Miscellaneous Electronics For Sale
510 – Miscellaneous Electronics Wanted
540 – Music & Accessories
570 – Plans-Kits-Schematics
630 – Repairs-Services
660 – Satellite Equipment
690 – Security
710 – Telephone
720 – Test Equipment

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #_____ **Special Category $20.00 Additional** _____

1 - $26.25	2 - $26.25	3 - $26.25	4 - $26.25
5 - $26.25	6 - $26.25	7 - $26.25	8 - $26.25
9 - $26.25	10 - $26.25	11 - $26.25	12 - $ 26.25
13 - $26.25	14 - $26.25	15 - $26.25	16 - $28.00
17 - $29.75	18 - $31.50	19 - $ 33.25	20 - $35.00
21 - $36.75	22 - $38.50	23 - $40.25	24 - $42.00
25 - $ 43.75	26 - $45.50	27 - $47.25	28 - $49.00

29 - $50.75	30 - $52.50	31 - $ 54.25	32 - $56.00
33 - $57.75	34 - $59.50	35 - $61.25	36 - $63.00
37 - $64.75	38 - $66.50	39 - $68.25	40- $70.00

Total words _____ $1.75 per word = $_____

Bold Face _____ $0.40 per word = $_____

Special Heading _____ $20.00 = $_____

Other_____ = $_____

Total classified ad payment $_____ **enclosed**

TOTAL COST OF AD **$** _____

[ ] Check **[ ] Mastercard** **[ ] Visa** **[ ] Discover**

Card # _____ Expiration Date __/__

Signature_____

Name _____ Phone _____

Address_____ City State Zip _____

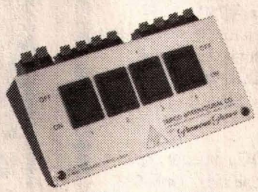
PARTS EXPRESS
ELECTRONICS & MORE

FREE 244 PAGE CATALOG

UNBELIEVABLE VALUE!

4 Way Speaker Switch

Control up to 4 pairs of speakers with this compact speaker selector switch. Features circuit protector, heavy duty rocker switches, spring loaded terminals, and silver plated switch connectors. Includes one pair of amplifier inputs. Load to amplifier is minimum 4 ohms (with 8 ohm speakers) or 220 ohms with all speakers switched off. Net weight: 1 lb.



	WAS	NOW
#PO-309-030	$22.50 EACH	$15.00 EACH

"The Sound Bridge" FM Stereo Wireless Transmitter

HOT NEW ITEM!

The Sound Bridge is a mini FM wireless transmitter that can be used to broadcast stereo sound from any audio source like portable CD players, TVs, electronic games, CD-ROM, even computer soundcards, to your home stereo receiver! Adjustable from 89 to 95.5 MHz.

#PO-249-220 ..... $14.95 EACH

Weller Professional Irons

Weller

Perfect for a variety of electronic soldering work, this top quality iron features a long life, double coated tip and a quick change, plug-in heater element. Lightweight handle includes a comfortable cushioned grip. Net weight: 1/2 lb.

#PO-372-110 (25 Watt)	$30.90 (1-3)	$28.50 (4-UP)
#PO-372-112 (35 Watt)	$38.90 (1-3)	$34.95 (4-UP)

Peak Instrument Co.

The Woofer Tester
QUICKLY AND ACCURATELY MEASURES: Fs, Qms, Qes, Qts, Vas, BL, Re, Le, SPL @ 1W/1m, Mmd, Cm, and Rm IN MINUTES!
◆ 30 DAY MONEY BACK GUARANTEE
◆ 1 YEAR WARRANTY ◆ SAME DAY SHIPPING

"The Woofer Tester"

Peak Instrument Co. proudly introduces "The Woofer Tester". Just ask any loudspeaker engineer, and they will tell that the only way to design enclosures of the correct size and tuning is to measure the Thiele-Small parameters for the actual drivers to be used. The reason? Manufacturers published specs can be off by as much as 50%! But until now, measuring the parameters yourself required expensive test equipment and tedious calculations, or super expensive measurement systems ($1,200 to $20,000). The Woofer Tester changes all that. Finally, a cost effective, yet extremely accurate way to derive Thiele-Small parameters, in only minutes! The Woofer Tester is a combination hardware and software system that will run on any IBM compatible computer that has EGA or better graphics capability and an RS232 serial port. The Woofer Tester will generate the following parameters. Raw driver data: Fs, Qms, Qes, Qts, Vas, BL, Re, Le, SPL @ 1W/1m, Mmd, Cm, and Rm. Sealed box data: Fsb and system Q. Vented box data: Fsb, ha, alpha, and Q loss. The Woofer Tester system includes hardware, test leads, serial cable, AC wall adaptor, detailed instructions, and software.

#PO-390-800 ..... $249.00 EACH

900 MHz Wireless Speaker System

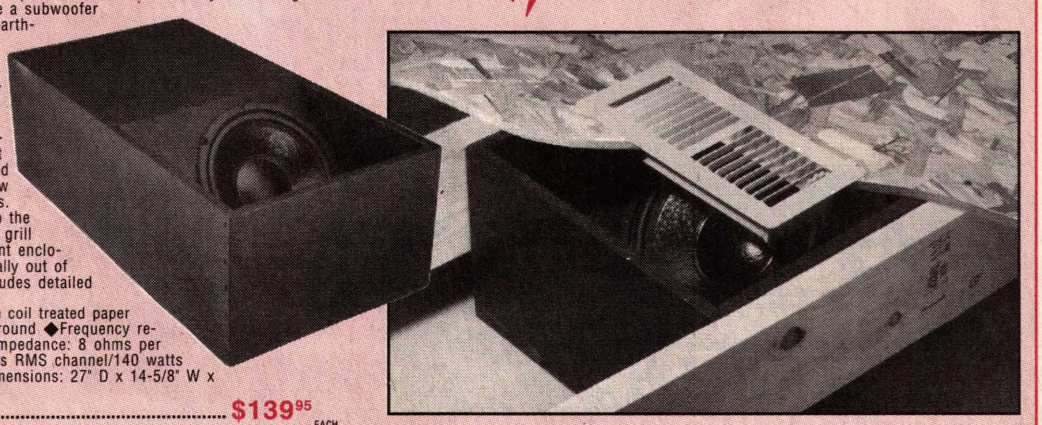
- 900 MHz technology sends signal up to 180 ft., through walls, floors and ceilings.
- Ideal for use as rear surround speakers or for adding wireless sound to every room in the house!
- Full range, bass reflex design with built-in high power, low distortion amplifier.
- Weather resistant cabinet for outdoor use.
- Selectable battery (six C size for each speaker) or AC operation, adaptor included. Built-in recharging circuitry for ni-cad batteries.
- System includes: 900 MHz transmitter, wireless speaker pair, AC adaptors, and all cables necessary to hook up system.
- Limited availability. ◆ Net weight 9 lbs.
- Frequency response: 20-18KHz.

#PO-319-030 ..... $169.95 EACH

Home Theatre In-Floor Subwoofer

Dayton Loudspeaker Co.®

To fully appreciate the potential of movie soundtracks, a dual voice coil subwoofer is a must! Many film special effects are extremely demanding in the low frequency range and require a subwoofer that can duplicate explosions, earthquakes, even the footsteps of Tyrannosaurus Rex! This subwoofer fits the bill by featuring a 10" dual voice coil woofer for true stereo operation and high pass filters for your main speakers. The most unique feature of this subwoofer is the fact that it is designed to be mounted in between the floor joists in new and existing home constructions. Simply mount the in-floor sub to the joists and mount a heat register grill above opening in subwoofer front enclosure. The subwoofer is now totally out of view and ready to rumble! Includes detailed installation manual.



Specifications: 10" dual voice coil treated paper cone woofer with poly foam surround ◆Frequency response: 30-100 Hz ◆Nominal impedance: 8 ohms per coil ◆Power handling: 100 watts RMS channel/140 watts max ◆SPL: 89 dB 1W/1m ◆Dimensions: 27" D x 14-5/8" W x 9" H ◆Net weight: 29 lbs.

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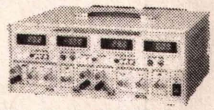
SINGLE OUTPUT *Analog Displays*

PS-303 $159.00, 30V/3A.
PS-305 $219.95, 30V/5A.
PS-1610S $289.00, 16V/10A.
PS-2243 $139.00, 12V/24V select, 3A.
PS-2245 $159.00, 12V/24V select, 5A.
8107 $399.95, 30V/10A.
8110 $289.95, 60V/3A.
8112 $399.95, 60V/5A.

Digital Voltmeter & Analog Ammeter
8200(8201) $179.95($239.95), 30V/3A(5A)
Digital Displays **8210/8300 $199.95**, 30V/3A.
8211/8301 $259.95, 30V/5A.

DUAL OUTPUTS
Independent/Tracking
Analog Displays



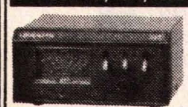
8108 $549.95, 60V/3A.
8109 $699.95, 60V/5A.
PS-303D $314.95, 30V/3A. **PS-305D $399.95**, 30V/5A.

TRIPLE OUTPUTS, a fixed 5V/3A output, Independ/Tracking
Digital Displays **8202(8203) $499.95($549.95)**, dual 30V/3A(5A).
Analog Displays **8102(8103) $399.95($489.95)**, dual 30V/3A(5A), with *Parallel* (30V/6A) and *Series* (60V/3A) Mode operation.

NTSC/PAL TV COLOR BAR GEN.

CPG-1366A $159.95, VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV.
Impedance: 75 Ohm;
Video Output: BNC, $1V_{p-p}$.
CPG-1367A $159.95, VHF PAL.

SWR/RF/mW POWER METER



310 $89.95, 1.8-150MHz; *RF Power*: 0-4W/20W/200W 3 ranges; *SWR Measurement.*:1.0~∞, 4W minimum. Accuracy: 5%-10%; *Insert Loss*: .3dB *Input/Output Imp.*: 50Ω; SO-239 plug
320 $89.95, 130-520MHz. Spec. 310.
330 $119.95, 1.8-520MHz. Spec. see 310.

SWR-3P $26.95 1.7-150MHz;
RF Power: 0.5-10W, 0.5W-100W.

SWR-2P $22.95, 1.7-30MHz; *RF Power*: 0.5-10W.

mW RF Power Meter 340 $219.00, 1.8-500MHz; *RF Power*: 20mW/200mW/2W 3 ranges; *Imped.*: 50Ω; *Accuracy*: ±10% full scale; SWR <1.15; N-type connector; BNC type output..

FM STEREO MODULATOR

AG-2011A $549.00
RF SECTION:

Carrier: 98MHz ±2MHz,
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%;*L-R Separation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Separation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz.

TOOLKITS - ELECTRONIC/PC

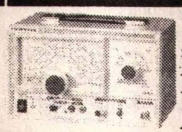
9Z45 $29.99 U.S. Patented, 45-pcs. Contents: IC inserter/extractor with securers & bows, 3-prong part retriever, #0 phillips screwdriver, 1/8" flat srewdriver, self-hold tweezers, metal tweezers, extra parts tube, soldering iron, solder, crimping tool, long-nose plier, cutting plier, zipper vinyl case. Bits include: *Phillips*: #0/#1/#2/#3; *Flat*: 1/8"/3/16"/1/4"/9/32"; PZ1/PZ2; T8/T9/T10/T15/T20/T25/T27/T30/T40/T45; *Hex*: 5/64"/3/32"/1/8"/5/32"/3/16"; *Sockets*: 3/16" (5mm)/7/32" (5.5mm)/1/4" (6mm)/9/32" (7mm)/5/16" (8mm).
8G23 $34.99 23-pcs *Contents*: IC inserter/extractor with securer & bows, 3-prong part retriever, 3/16"/1/4" nutdriver, 3/16"/ 1/8" slotted screwdriver, #0/#1 phillips, reversible T10/T15 bits, re-versible #2 phillips/¼" slotted bits, tweezer, long-nose plier, cutter, 6" adj. wrench, soldering iron, solder, crimping tool, zipper case, manual.
Different packages available, call/write/e-mail/fax for detail.

STEREO/ALIGNMENT/SWEEMAR SCOPE

STEREO SCOPE **OS-7505B $369.00**, 0-10MHz/20mV.
ALIGNMENT SCOPE OS-7001A $369.00, 0-200KHz/1mV.

SWEEMAR SM-6225B/C $1999.95
Freq Range: (AM)490KHz; (FM)10-11.4MHz; *Accuracy*: ± 0.1%; *Marker*: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

RF SIGNAL GENERATOR

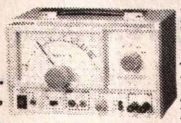


SG-4160B $124.95, 100KHz-150MHz up to 450MHz on 3rd harmonics in 6 ranges; AM modulation; *Accuracy*: ±5%. *RF Output*: 100mVrms to 35 MHz; *Modulation*: Int. 1KHz (AM) ≈30%; Ext. 50Hz-20KHz, at least $1V_{rms}$ input. *Audio Output*: 1KHz, $2V_{rms}$ minimum.
SG-4162AD (with Freq. Counter) $229.95, Spec. see SG-4160B.
COUNTER SECTION: 10Hz-150MHz; *Max. Input*: ≤3V effective *Gate Time*: .1, 1sec. *Input Sensitivity*: *35mV, 10Hz-200MHz.* *Input Impedance*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs.

AM/FM STD SIGNAL GEN.

SG-4110A $1799.00, *Freq*: 0.1~110MHz; *Display*: 6-digit LED; Resolution: 100Hz (0.1~34.999MHz); 1KHz (35MHz~110MHz). *Accuracy*: <±($5x10^5$ ±1 count); *Output*: -19dBu~-99dBu, 1dB steps. *Impedance*: 50Ω VSWR 1.2; 100 preset frequency & store functions

AUDIO GENERATOR

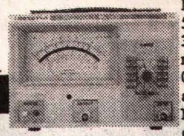


AG-2601A $124.95, 10Hz~1MHz in 5 ranges; *Output*: sinewave 0~$8V_{rms}$; square $10V_{p-p}$. *Output Imped*: 600 Ohm. *Distortion*: <0.05% 500Hz~50KHz; <0.5% 50KHz~500KHz.
AG-2603AD $229.95, with 6-digit, Int/Ext. Freq Counter, 10Hz~150MHz, *Output Control*: 0/-20/-40dB & Fine adjuster. Spec. see AG-2601A.

FUNCTION GENERATOR

FG-2100A $169.95, 0.2Hz-2MHz in 7 ranges; sne, square, triangle, pulse & Ramp; *Output*: $5mV_{p-p}$-$20V_{p-p}$, 1% distortion. *VCF*: 0-10V/freq. to 1000:1.
FG-2102AD $229.95 see FG-2100A; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
FG-2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG. *Freq. Counter*: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz.
FG-513 $769.95, 13 MHz, Microprocessor embedded dgital sweep; Sine, Square, Triangle, Pulse, Ramp, TTL & DC; ±(.01%+1dgt). *Freq. Counter & TCXO*: 5Hz-100MHz, 6.5 digits. x1/x20 attenuatn

AC MILLIVOLT METER



MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV, dB &dBm; 300μV~100V in 12 ranges, 10μV resolution; -70~40dB in 12 ranges, 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedance 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement..

OSCILLOSCOPES

OS-7305B $249.00 DC~7MHz, 3" CRT; *Horz*: .25V/div; 10Hz~100KHz in 4 ranges; *Vert*: 10mV/div; Int. & Ext. Sync.; *Input*: 1MΩ/35pF.
OS-7010A $299.95 10MHz, 5"CRT, *Horz*: .2V/div; *Vert*:10mV~10V /div.
OS-622G $389.95 20MHz, 2 CH/X-Y Alt trigger, trigger lock, hold OFF, TV syn., 8x10 div., 1mV/div., *Horz*: .2μs~.5s/div; *Vert*: 1mV~5V/div.
OS-653G $699.95 50MHz, 2 CH/delay sweep, Alt trigger, TV syn.
OS-6101G $1499.95 100MHz, 4ch/8 traces, delay sweep, cursor readout. *2 years warranty for OS-622G, OS-653G, & OS-6101G.*

UHF ATTENUATORS

RT-8815U (50Ω) $299.00 / RT-8817U (75Ω) $299.00, 950MHz, 81dB, 0.5W max.; *Steps*: 1/2/3/5/10/20/20/20, 8 switches.
085E-2 (50Ω) $399.00 / 087E-2 (75Ω) $399.00, 950MHz, 81dB, 0.5W max.; *Steps*: 10dB+7.1dBx10, Electronic adjustment knob.

MICROPROCESSOR TRAINER

BGC-8088 $699.00, learn computer theory. Excellent for school & individual who want to learn about ROM, RAM, I/O ports, programming, & run a 8088 Microprocessor. An easy to understand step-by-step manual guides you to achieve your goal. 56-key keyboard, LCD display, RS-232, UART...

GRID DIP METER

DM-4061 $89.95 1.5-250MHz, 6 bands; 6 plug-in coils, 2 transistor, and 1 diode. *Modulation:*≈ 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absorption meter. 9VDC battery.

FREQUENCY COUNTER

FC-5250C $119.95 10Hz-220MHz (HF)10Hz-20MHz, (VHF)10-200MHz. *GateTime*: .1, 1sec. *Max. Input*: $10V_{p-p}$. *Input Sensitivity*: 35mV/10Hz-200MHz *Input Imped.*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs; 9V adapter **($6)**

FC-5260A $129.95
10Hz-600MHz. 7-digit LEDs.
FC-5270 $149.95
10Hz-1.2GHz; 8-digit LEDs.
FC-5600B $229.95
10Hz-600MHz, 10-digit LEDs.
FC-5700 $299.95 10Hz~1.3GHz; 10-digit LEDs. Period measure.

SIGNAL TRACER/INJECTOR

SE-6100 $134.95 (9VDC adapter, $6.0)
TRACER: Gain 60dB **maximum.** *Attenuation:* 0/20/40/60dB *Input Imped:* 100KΩ; *Meter:* Vu 100μA *Output Imped.*: 600Ω; *Speaker:* 8 Ω.
INJECTOR: ≈1KHz Squarewave; *Output Level:* Continuously variable 0 ~ $4.5V_{p-p}$; 9V battery/adaptor

LCR METERS

MIC-4070D $179.95, *Induct.*: 0.1μ~200H, *Capacit.*: 0.1p~20mF, *Resist.*: 1mΩ~20MΩ, 2Ω range, Dissipation factor measurement, Zero adjust; Surface mount device (SMD) test probe: **LT-06 $21.95**

DIGITAL MULTIMETER

DMM-120 $24.95, 3½ digit, 600VDC, 2ADC 500VAC, 2MΩ, hFE/diode/continuity test.
DMM-123+Capacitance $44.95, 3½ digit, 600VDC/600VAC, 10ADC/AC, 2GΩ, 20μF, hFE/diode test, continuity beeper.
DMM-124+Cap.+Temp.+Freq Cntr $69.95, 3½ dig, 600VDC/500VAC, -58~752° F, 2GΩ, 20mF, 200KHz, 3φ phase/diode/continuity test.
DMM-125 $54.95, Autorange/Bargraph, 32MΩ, 600VDC/AC, 10ADC/AC, diode/continuity test.
MIC-35 $59.95, Autorange, 3½ digit LCD, 1000VDC/750VAC, 20MΩ, 20ADC/AC, diode/continuity check, data hold, free holster.
MIC-39 $129.95, Autorange/Bar Graph, True RMS, 3¾ digit, LCD, 40MΩ, 40μF, 1000VDC/750VAC, 20ADC/AC, 600KHz freq. cntr, data hold, drop-prove, sleep mode, memory, read functions, holster..

AUTO. CAPACITANCE METER

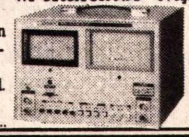
CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic. *Resolution*: 0.1pF lowest, 0.1% full scale. *Accuracy*:
0.5% of full scale ±1 digit to 99.9μF,
1% of full scale ±1 digit to 99.9μF.
Display: 3 digit LED.
Unit: pF, nF, μF, mF, Overrange indicators.

AUTO DISTORTION METER

DM-3104A $799.95
DISTORTION MEASURE
Range: 0.01% to 30%,
0.1/0.3/1/3/10/30% 6 ranges.
Freq: 400Hz±10%, 1KHz±10%(HPF).
Input: 3mV-100V; Ratio measure 20dB.
Auto. Freq. Switching Ranges:
Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
LEVEL MEASURE *Range*: 0 to 100V in .03/.1/.3/1/3/10/30/100V
Freq Response: ±0.5dB/20~50kHz; ±1dB/20~100kHz.
DM-3204 $1,599.00 dual channels; Spec see DM-3104A.

WOW-FLUTTER METER

WF-3103A $699.95 *Freq. Range*: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN.



Measuremt: .03/.1/.3/1/3% full scale.
Accuracy: ±5% of full scall.
WF-3105A $799.95, digital display;
Function: LIN/WOW/Flutter/WTD.
Freq Counter: 10Hz-9.99MHz.
Indication: CCIR/DIN/JIS.

CIRCLE 49 ON FREE INFORMATION CARD

Modern computing and standard surge suppressors...a recipe for disaster.

Almost all surge protection devices use MOV's (metal oxide varistors) as their active element. MOV's are sacrificial/wear/limited life components. Surge suppressors based on this technology are doomed to failure. These surge "suppressors" also don't suppress a thing. They divert powerline surges equally to the ground and neutral wire. When you put current on the common ground wire of interconnected equipment some of that current will flow (through the inherent ground loops) to the data lines. This is a major cause of lock-ups and misoperations that plague today's computer environments. Another fact; all modern computers use switch mode power supplies. During surges the power supply capacitors must charge to the clamping level of the MOV before the MOV turns on. A recent study has shown that it takes a 3000A surge 15 microseconds (15,000 nanoseconds) to charge the typical capacitors of these power supplies to that level. The surge is virtually over before the MOV reacts. ***(See five things you probably don't know about your surge suppressor at www.fivethings.com.)***

THE POINT: Standard surge suppressors allow too much current to hit the computer. Standard surge suppressors divert surge current to the ground wire and disrupt data transfer. Standard surge suppressors eventually fail without warning. Modern computers have logic voltage levels (the signals that transmit the data) and power supply voltages that are dramatically lower than that of their recent predecessors. Modern computers use integrated circuits with transistors of ever decreasing physical geometries. Modern computers are virtually always interconnected to other computers or peripheral equipment. The bottom line; ***modern computers are much more sensitive and susceptible to powerline anomalies.***

INTRODUCING BRICK WALL SURGE FILTERS. . .

The World's Best Surge Suppressor

Initially engineered for critical, non-fail industrial applications, this patented device protects indefinitely and sets a new standard for every measure of surge suppressor and powerline filtering performance.

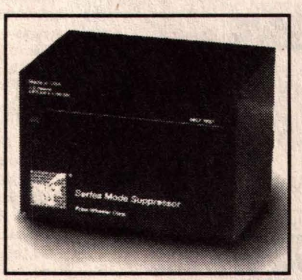
A Brick Wall 1) Utilizes *NO MOV'S* or Any Other Sacrificial Components (a two pound inductor and nine capacitors are the heart of the unit) 2) Has No Joule Rating or Surge Current Limitations *3) HAS BEEN TESTED AND CERTIFIED BY UL TO THE MOST DEMANDING CLASSIFICATION OF A NEW GOVERNMENT SPECIFICATION; CLASS I, GRADE A. Which Means: UL PUT ONE THOUSAND 3OOOA, 6000V SURGES (this is the largest surge an interior environment can experience) THROUGH A UNIT (at 60 second intervals) AND DOCUMENTED NO FAILURE OR PERFORMANCE DEGRADATION OF ANY KIND WHATSOEVER..*

i.e.: A Brick Wall Will Not Fail.

We know of no cord connected, MOV based surge protection device that has, or can pass this test.

A Brick Wall possesses UL's lowest Suppressed Voltage Rating (let-through voltage) of 330V. This is the lowest rating they will grant. In that test of one thousand 6000V, 3000A surges, *UL NEVER SAW THE LET-THROUGH VOLTAGE EXCEED 290V. YOU CANNOT DO BETTER THAN THIS FOR A POINT-OF-USE SURGE PROTECTION DEVICE.* Once again, we know of no other surge protection device that could come close to this performance level.

A Brick Wall is a current activated *Series Mode* device. *Since it is not wired in parallel, nor voltage activated, it does not have to wait for the capacitors of the power supply to charge before it becomes effective. YOUR EQUIPMENT IS PROTECTED INSTANTANEOUSLY (and indefinitely).*



These devices were engineered utilizing a current limiting/surge filtering technology. *THEY DO NOT DIVERT ANY SURGE CURRENT TO THE GROUND WIRE. They Will Not Cause Your Computer System To LOCK-UP, CRASH OR MISOPERATE as a consequence of surge diversion. Your current surge "suppressor" will.*

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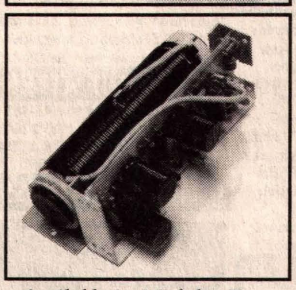

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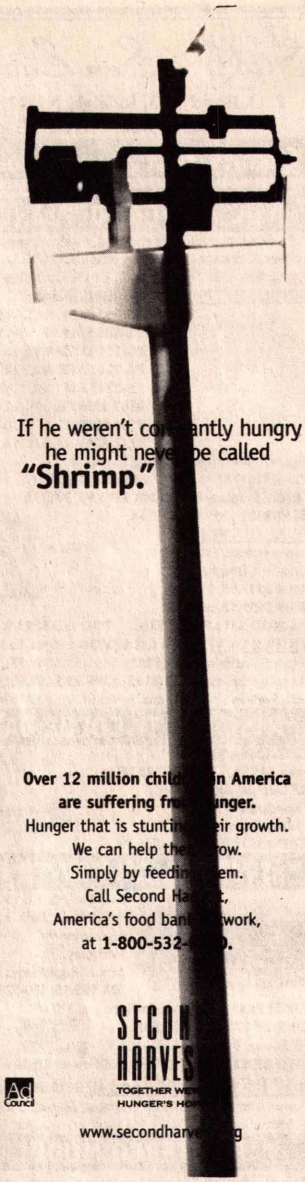

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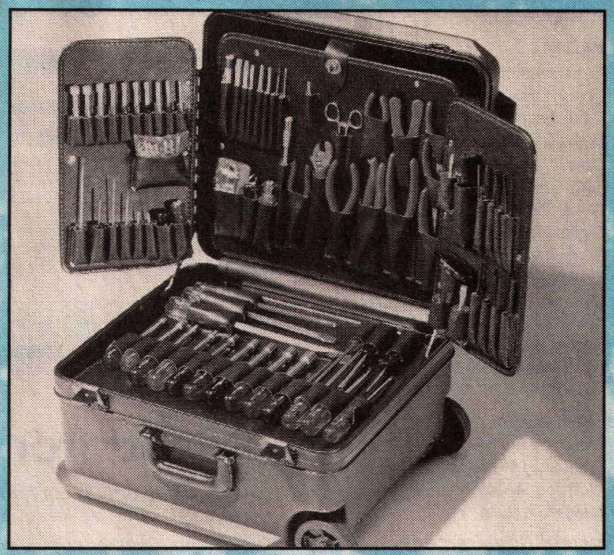

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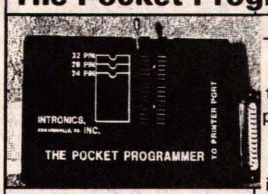

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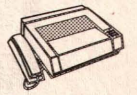

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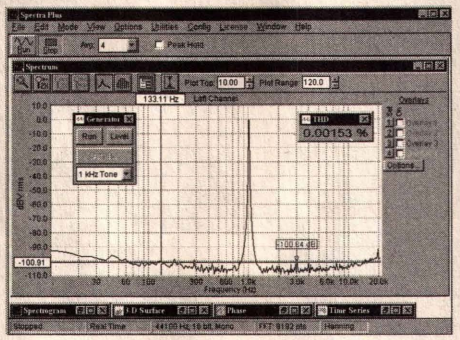

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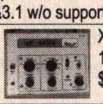

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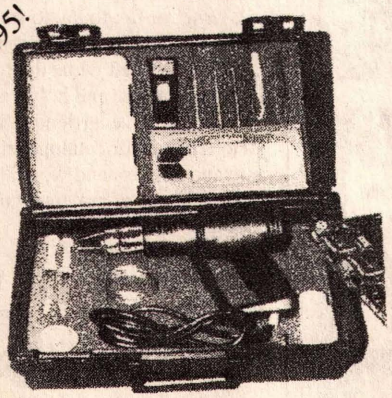

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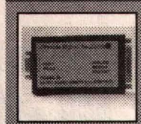

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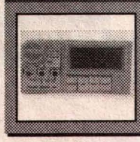

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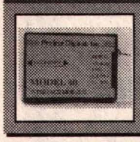

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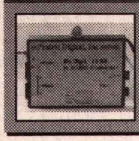

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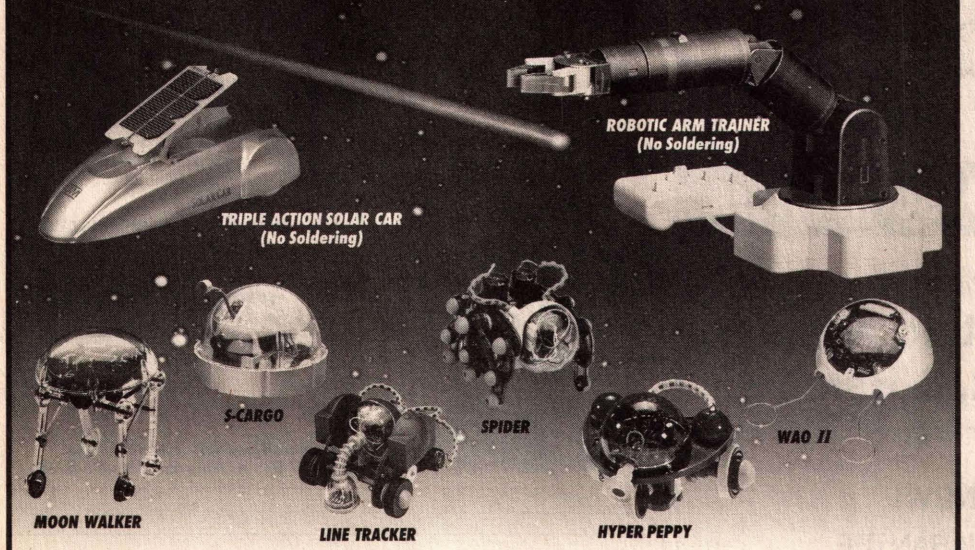

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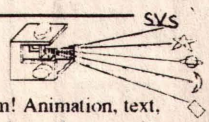

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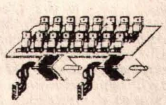

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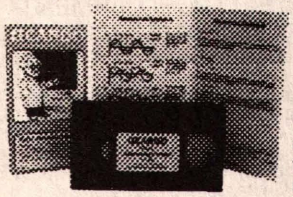

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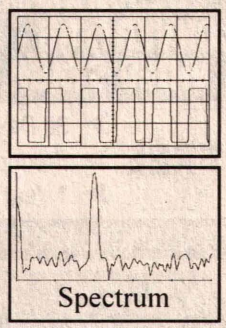

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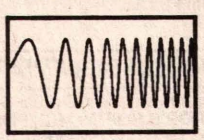
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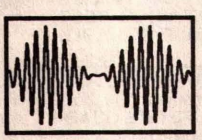
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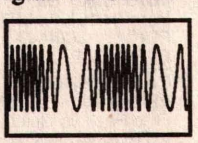
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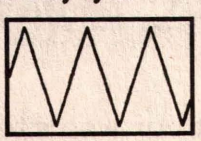
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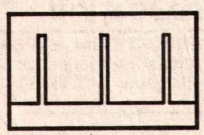
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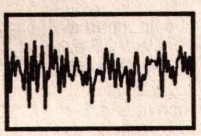
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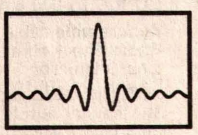
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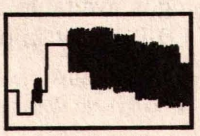
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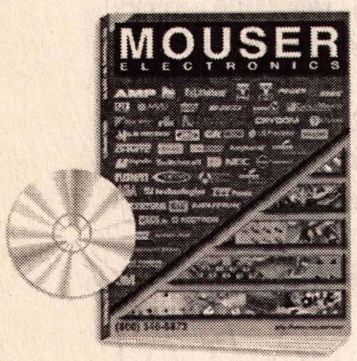

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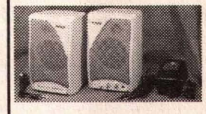

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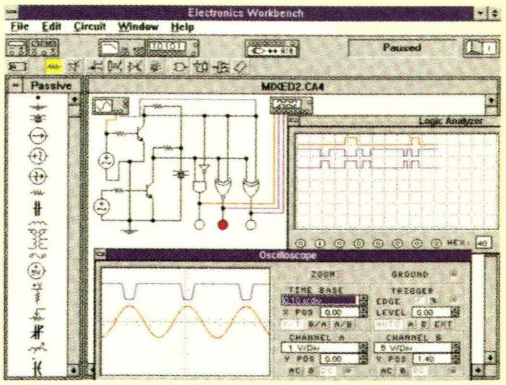

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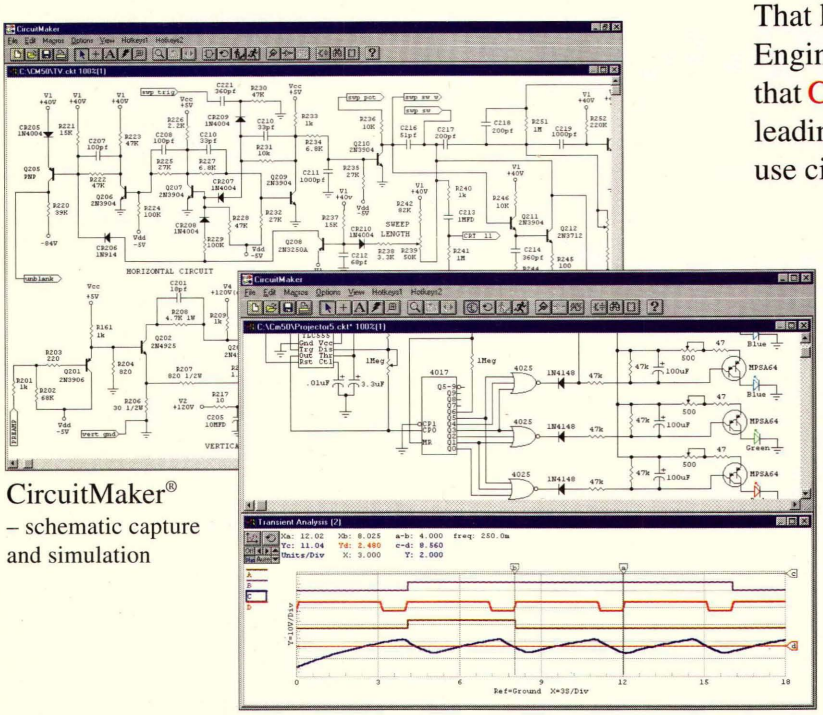


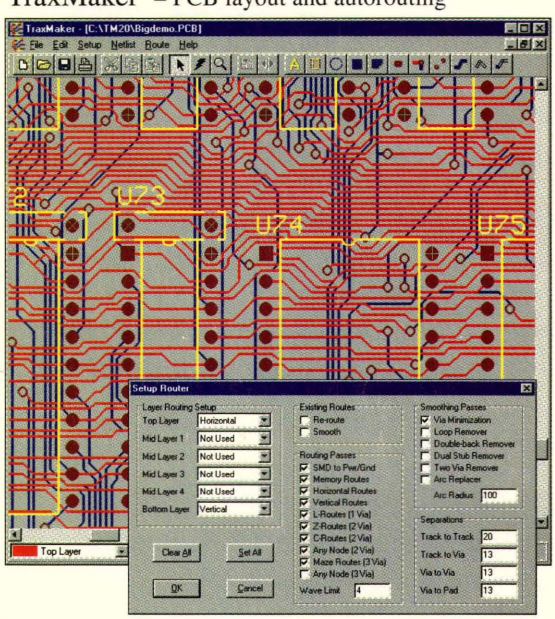
CircuitMaker®
– schematic capture and simulation

QUICKLY DESIGN analog, digital or mixed analog/digital circuits with CircuitMaker's advanced schematic features. You fully control the wiring, device placement, annotation and colors. And the Symbol Editor and macro features let you create unlimited custom devices and symbols.

SIMULATE and **ANALYZE** what you create – try all the "what if" scenarios with:

- Fast, proven 32-bit SPICE 3f5/XSpice simulator
- True mixed analog/digital simulation
- Fully interactive digital logic simulation
- 4,000-device library
- AC Frequency Analysis
- DC Operating Point Analysis
- DC Transfer Function
- Transient Analysis
- Step Function – step component values and sources over a user-definable range

TraxMaker® – PCB layout and autorouting



TAKE MEASUREMENTS at any point in the circuit with a click of the Probe tool. Results appear immediately on virtual instruments like the Digital Oscilloscope, Curve Tracer, Digital Multimeter and Bode Plotter. No other simulator lets you take measurements as quickly and easily as CircuitMaker.

COMPLETE the design process with TraxMaker, a professional printed circuit board layout program with built-in autorouter. Import netlists from CircuitMaker and other schematic programs, or design boards from scratch.

- Includes autorouter, auto component placement and Design Rules Check
- Supports up to 8 copper layers, board sizes up to 32 x 32 inches
- Surface mount and through-hole components from a customizable library
- Outputs your PCB as a Gerber file, Excellon N/C drill file, and prints to any Windows-selectable printer or plotter

RELY ON free technical support from qualified engineers. And every MicroCode product is backed by our **30-day Money-Back Guarantee** if it does not live up to your expectations.

Call 800-419-4242 for more information and free demos

(or download from www.microcode.com)

CIRCLE 171 ON FREE INFORMATION CARD

CircuitMaker Version 5	**$299**
TraxMaker Version 2	**$299**
CircuitMaker Design Suite™ (CircuitMaker and TraxMaker)	**$549**

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